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MANU-MENTAL COMPUTATION

WOODFORD D. ANDERSON

Compliments of the
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President Roosevelt.

New York, Dec. 12, 1904.

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FIGURE 1.

MANU-MENTAL COMPUTATION

BY

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NEW YORK, 1904

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To My Mother,

Who Patiently Drilled Me in the
First Principles of Mathematics,
This Book Is Affectionately
Dedicated.

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INTRODUCTION.

In this day of advanced methods every progressive teacher will welcome any device that will save time and increase accuracy.

The author's experience as teacher in one ungraded country school, one graded school, three high schools, two colleges and one State university, has convinced him that most students of arithmetic (possibly in most mathematics) are slaves to the pencil or chalk, and are unable to reason independently or to remember their results longer than it requires to write them. He believes the student should be taught "mental" or "intellectual" arithmetic until he is able to reason clearly, compute accurately and remember results until the desired conclusion is obtained.

On several occasions the author has suggested to men of recognized mathematical ability that the use of pencil and chalk should be discouraged among pupils, and has invariably been met by the reply that students cannot add large numbers without aids, nor spare time enough to learn the multiplication table to 100 times 100, and that few students could remember it if it were taught.

The author set to work to discover some method by which the student could add large numbers without the use of the pencil or chalk, and found the "joints" and "balls" of the fingers admirably adaptable for this process. After a brief trial he discovered that subtraction, multiplication, and division could be readily performed by the same method.

This system gradually developed itself until, by the use of the fingers, the average student can—

1. Read all numbers below one quadrillion as accurately as he can to one thousand, and save at least half the time required to learn it.

2. Write all numbers below one quadrillion as accurately as he can to one thousand, and save more than half of the time needed to learn it.

3. Write decimals from the decimal point without having to enumerate to place the point.

4. Read decimals without pausing to read the denominator.

5. Add any numbers to the sum of one million. (By continued use of this method the student can soon learn to add and subtract numbers of two, three, or four figures mentally.)

6. Subtract where neither number exceeds one million.

7. Multiply any numbers whose product does not exceed one million.

8. Divide one million, or less, by any number below it.

9. Solve most practical problems in arithmetic without the use of pencil or chalk.

10. Cultivate the memory and develop marvelous mathematical skill.

The teacher should be sure that he understands the principles thoroughly, and can perform the operations readily. He should be careful to see that the student does the same.

In presenting this volume to the public, the author does not claim to present a complete arithmetic; nor does he desire that it shall be substituted for a textbook; but he hopes that its use, in connection with textbooks now in use, will revolutionize the teaching of arithmetic and

greatly increase the independence and efficiency of the student and business man.

The problems given are intended to show what can be done by the Manu-Mental method, and to suggest the kind of problems necessary for the student to gain proficiency. Where one is given in this book, a dozen or more similar ones may be selected from the textbook.

While the author claims originality in the Manu-Mental method, he desires to express his obligation to his teachers who helped him to think independently; to Superintendent Wm. E. Chancellor, of Bloomfield, N. J., for advice concerning name and publication, and to the students of the Bloomfield High School (N. J.) and Girls' Technical High School (New York City) for clerical work and testing the Manu-Mental method.

The author realizes that it would be almost impossible to present a new method of computation without errors; he therefore invites corrections, criticisms, and suggestions, and will gladly answer any questions concerning the work.

THE AUTHOR.

New York, July 4, 1904.

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MANU-MENTAL COMPUTATION.

NOTATION.

1. Write numbers below one thousand in the order of "hundreds," "tens," "units."

NOTE 1.—Students should not be allowed to enumerate by saying "units," "tens," "hundreds," "thousands," "tens of thousands," etc. The fact that children begin with one and count to one thousand is no reason for learning the orders in the same direction.

2. Give the fingers of the left hand the names of the periods; beginning with the thumb, call it trillions, the first finger billions, the second finger millions, the third finger thousands, and the fourth finger units—as per accompanying illustration (Fig. 2).

NOTE 2.—To read and write numbers students always begin with the highest order and go toward units, so they should learn the periods in the order of trillions, billions, millions, thousands, units, and not as they usually do; *i. e.*, beginning with units.

3. Each finger represents three figures, or the hundreds, tens and units of the period for which the finger is named: *i.e.*, the first finger represents hundreds of billions, tens of billions and billions; the second finger represents hundreds of millions, tens of millions, millions; etc.

4. Place the back of the left hand against the blackboard. Spread the fingers far apart and keep them at even distances from each other.

NOTE 3.—In this position a line drawn straight from the little finger should reach the decimal point; one from the third finger should come between thousands and hundreds; one from the second finger should come between millions and hundreds of thousands; etc. (Fig. 2.)

5. Write the one, two or three figures in each order before (to the left of) the finger which bears the name of that order; write the next lower order in the same manner, filling all vacant places with ciphers. Continue this process until the decimal point is reached.

(N. B. Notation and Numeration of Decimals are explained later.)

6. Write:

1. Six hundred forty-three.
2. Eight hundred seventy-eight.
3. Seven hundred eighty-five.
4. Eight hundred six.
5. Six hundred ninety-seven.
6. Sixty-two thousand four hundred eighty-three.
7. Seven thousand eight hundred ninety-two.
8. Four hundred thirteen thousand two hundred fifty-four.
9. Seventy million forty thousand two hundred twenty-six.
10. Thirty-eight billion four hundred thirty-two million seventy-five thousand two hundred forty-seven.
11. Two trillion seven hundred sixty-four billion three hundred eighty-two million seven hundred forty thousand six hundred eighty-three.
12. Three hundred forty-two trillion seven hundred eight million sixty-five thousand seven hundred.
13. Eleven trillion one hundred ten billion one million one hundred one.
14. Three hundred trillion six million twenty-two thousand four hundred eighty.
15. Nine hundred sixty-four trillion three hundred five billion seventy-two million seven hundred thousand four hundred sixty-two.

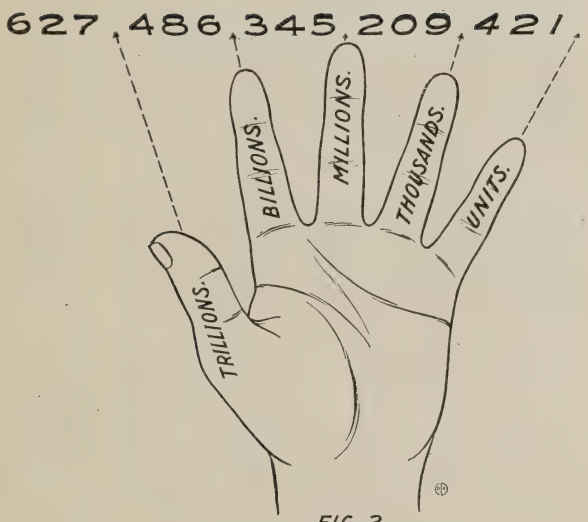


FIG. 2.
NOTATION AND NUMERATION.

NUMERATION.

7. To read a number, place the left hand with the back to the board or paper, in such a position that the fourth (little) finger points to the decimal point, the third finger, between the third and fourth figures (counting from the right end of the number), etc., so that three figures will be between each finger and the next higher used.

Beginning with the left or highest number, read the figures to the left of each finger as a whole number, and add the name of the finger; continue this till the decimal point is reached. (Fig. 2.)

NOTE 4.—Have the student learn to write and read numbers on the blackboard, where the figures can be made large enough to place the fingers between the periods without crowding them. After this has been done thoroughly, the student can handle small figures on paper without difficulty.

8. Read the following:

1.	346.	16.	20342700321.
2.	478.	17.	146398462064.
3.	586.	18.	4482918000.
4.	116.	19.	1006070800989.
5.	796.	20.	3860472834672.
6.	38462.	21.	789342876395825.
7.	29870.	22.	802341078639582.
8.	225316.	23.	304027894030.
9.	1420340.	24.	10001001101110.
10.	7200408.	25.	27830472578334.
11.	3046705.	26.	580008573095785.
12.	12202007.	27.	90000087366409.
13.	28004962.	28.	405030765003.
14.	665566488.	29.	57839567584.
15.	704400096.	30.	7468000567008.

CHECK READING.

9. In many business houses where checking is done the numbers are read in the shortest manner possible.

In reading numbers of three places, the word "hundred" is omitted and a short pause made between the hundreds and tens. 784 is read seven, eighty-four, instead of seven hundred eighty-four (7,84).

In reading numbers of four places, the pause is made at the same place. 6791 is read sixty-seven, ninety-one, instead of six thousand seven hundred ninety-one (67,91).

In reading numbers of five places, the pause is made between thousands and hundreds and between hundreds and tens. 36842 is read thirty-six, eight, forty-two, instead of thirty-six thousand eight hundred forty-two (36,8,42).

In reading numbers of six places, the pauses are made between hundred thousands and ten thousands, thousands and hundreds, and hundreds and tens. 724936 is read seven, twenty-four, nine, thirty-six, instead of seven hundred twenty-four thousand nine hundred thirty-six (7,24,9,36).

In checking, the check mark (✓), dash (—) and dot (.) are the marks usually used. Each should be used for a definite and distinct purpose. A good rule is to use the dot for numbers to be added (ledger, etc.); the dash where the numbers must be rechecked (recheck with a perpendicular line across the dash or a dot above it); and the check mark for final numbers and totals.

Each good business house has a definite rule of its own, but there is no uniformity of usage.

RECORDING.

10. In recording, the thumb represents tens of thousands; the first finger, thousands; the second finger, hundreds; the third finger, tens; and the fourth finger, units. (Fig. 3.)

NOTE 5.—It will be noted that, in numeration and notation, the hand is spread and each finger represents three orders or a period, while in addition, subtraction, multiplication, and division, the fingers are not spread and each finger represents only one order.

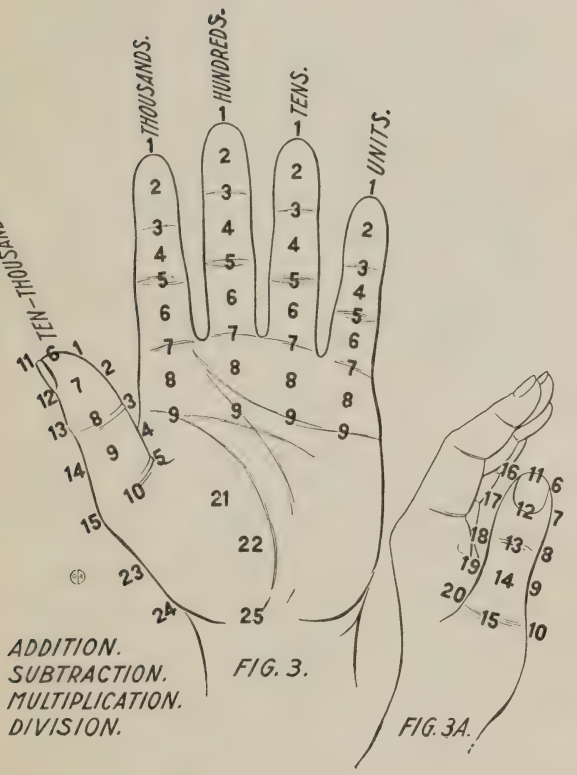
11. The end of the finger represents 1,
the first ball 2,
the first joint 3,
the second ball 4,
the second joint 5,
the third ball 6,
the third joint 7,
the fourth ball 8,
the crease in palm of hand 9.

NOTE 6.—It will be noticed that the ends and joints of the fingers represent odd numbers, and the balls represent even numbers.

12. The thumb is numbered on front from 1 to 5, outside 6 to 10, back 11 to 15, inside 16 to 20, and the base 21 to 25, as per illustration (Fig. 3). In recording 16 to 20 on the thumb, the thumb of the right hand comes between the thumb and the first finger of the left hand, with the right thumb nail against the left thumb.

13. The thumb and fingers of the right hand are used as pointers to keep the record on the left hand. They are called "pointers." The record is made on the left hand, so it is called the "record hand," and its fingers are called the "record fingers."

14. To record a number on the left hand, place the corresponding fingers of the right hand on the joints or



ADDITION.
SUBTRACTION.
MULTIPLICATION.
DIVISION.

FIG. 3.

FIG. 3A.

balls that represent the number of units in each order contained in the number. (Fig. 3.) (Position, Fig. 1).

15. Illustration 1:

Record 625.

To record 625, place the 2nd finger of the right hand on the 3rd ball of the 2nd finger of the left hand (marked "6," Fig. 3,), the third finger of the right hand on the first ball of the third finger of the left hand (marked "2,"Fig. 3.), and the fourth finger of the right hand on the second joint of the fourth finger of the left hand (marked "5," Fig. 3). Fig. 1 holds on record 58631.

NOTE 7.—Practice recording numbers by this method until it can be done quickly and accurately. It will be readily seen, by reference to Fig. 3, that 25 tens of thousands (250,000) can be recorded by this method. As comparatively few computations use such large numbers, the Manu-Mental method is sufficient for most problems. (See note 12.)

16. Record the following:

1. 42.	11. 1130.	21. 189645.
2. 368.	12. 5682.	22. 212416.
3. 295.	13. 7906.	23. 238044.
4. 318.	14. 4045.	24. 256800.
5. 406.	15. 5007.	25. 250400.
6. 900.	16. 13640.	26. 178423.
7. 784.	17. 25896.	27. 250074.
8. 340.	18. 34276.	28. 116020.
9. 676.	19. 80603.	29. 205790.
10. 192.	20. 20487.	30. 189500.

ADDITION.

17. To add, record the first number on the left hand; add the next number by beginning with its highest order, moving the recording finger downward on the record finger (finger of the left hand) as many points as there are units in the digit in the order to be added:

If this moves the recording finger past the crease in the palm of the hand, move the next higher finger one point—as in carrying 10—then return the recording finger to the end of the corresponding finger (marked "1") and continue to move downward until all the units of that digit are used:

Move the next lower finger of the right hand downward on the left, in the same manner; continue this until all the orders have been added, at which time the sum will be recorded on the fingers.

18. Illustration 2:

Add 215 and 432.

Record 215; move the second finger downward four points, to 6, the third finger downward three points, to 4, and the fourth finger downward two points, to 7, then the record is 6, 4, 7, or 647 for the sum.

NOTE 8.—At first it is better to add numbers in which the sum of the digits in any column will not exceed nine: practice this until the result can be obtained quickly and the student has confidence in his results.

19. Illustration 3:

Add 321, 417, and 537.

Record 321; move the second finger downward four points, to 7, the third finger downward one point, to 3, and the fourth finger downward seven points, to 8; then the record is 7, 3, 8, or 738.

To add 537 to 738, move the second finger down five points, to 12; (as twelve cannot be recorded on the second finger, record the one on the first finger, as in carrying ten, and the two on the second finger). Move the third finger down three points, to 6, and the fourth finger down seven points, to 15; (as 15 cannot be recorded on the fourth finger, record the five and move the third finger down one point, as in carrying 10, to 7), and the record stands 1, 2, 7, 5, or 1275.

NOTE 9.—It is well to confine this operation to two or three numbers, of not more than three figures each, until the student has confidence in the method and is positive of the correctness of his results. After that the operation may be extended until the sum equals 250,000. The sum may be extended to 1,000,000, as explained in note 12.

20. Add the following:

1.	2.	3.	4.
21	26	77	65
33	42	20	21
5.	6.	7.	8.
124	362	324	368
232	324	572	684
241	103	349	238
9.	10.	11.	12.
26	897	685	768
86	945	467	319
92	530	268	864
65	467	867	945
78	970	905	833
13.	14.	15.	16.
2634	3468	15421	78630
3268	2567	18963	22340
9473	4847	60325	90416
2867	4862	31872	26590
4755	9743	23957	19685

MULTI-COLUMN ADDITION.

21. Many bookkeepers add two, three or four columns at the same time.

To add two columns, place the hand so one finger will come on each column just below the first number; draw the finger on tens column down below the next number; add the number thus exposed to the tens above; draw the finger on units column down the same distance; add the figure thus exposed to the units above, carrying the tens, if there are any, to the tens column; continue this until the fingers reach the bottom of both columns.

To add more than two columns, place a finger on each column, draw the fingers down on ten-thousands, thousands, hundreds, tens and units columns, adding each figure exposed to the number already in its order.

22. Add the following:

1.	2.	3.
34	232	3487
42	311	2326
33	416	3586
27	534	9864
96	896	7839
74	347	5787

Place the fingers and draw them down as directed above; after each move call the result as follows:

23. Illustration 4: 34; 74, 76; 106, 109; 129, 136; 226, 232; 302, 306.

24. Illustration 5: 232; 532, 542, 543; 943, 953, 959; 1459, 1489, 1493; 2293, 2383, 2389; 2689, 2729, 2736.

25. Illustration 6: 3487; 5487, 5787, 5807, 5813; 8813, 9313, 9393, 9399; 18399, 19199, 19259, 19263; 26263, 27063, 27093, 27102; 32102, 32802, 32882, 32889.

SUBTRACTION.

26. Record the minuend on the fingers of the left hand. Beginning with the highest order of the subtrahend, subtract it by moving the pointer (finger on the right hand) up toward the end of the finger as many points as there are units in the digit of that order.

Subtract the next lower order in the same way, and continue this until "units" are subtracted, at which time the remainder is recorded.

If moving any pointer upward the required number of points takes it off the end of the finger, move the pointer for the next higher order upward one point, counting this move as a point, then return to "nine" and continue to subtract as before. (This is equivalent to reducing one of the next higher order to ten of the lower order.) In many cases it is more easily performed by adding the complement of the figure to be subtracted and subtracting one from the next higher order.

27. Illustration 7:

Subtract 325 from 746.

Record 746 on the left hand. Subtract 3 hundred from 7 hundred by moving the second finger of the right hand three points toward the end of the finger on the left hand; *i.e.*, to 4. Subtract 2 tens from 4 tens by moving the third finger of the right hand up two points; *i.e.*, to 2. Subtract 5 units from 6 units by moving the fourth finger of the right hand up five points; *i.e.*, to 1. The record is 4, 2, 1, or 421 for the remainder.

NOTE 10.—A number of problems, where each figure in the minuend is larger than the figure in the corresponding order of the subtrahend, should be given for practice before attempting problems where it is necessary to reduce one from the next higher order.

28. Illustration 8:

Subtract 389 from 654.

Record 654 on the left hand. Subtract 3 hundred from 6 hundred by moving the second finger up three points; *i.e.*, to 3. Subtract 8 tens from 5 tens by moving the third finger up five points (this takes it off the end of the record finger, so the second finger must be moved up one point, to 2), then take it back to 9 (which move counts one point, or six points moved) and move it up two more points, to 7. Subtract 9 units from 4 units by moving the fourth finger up four points (this takes it off the end of the record finger, so the third finger must be moved up one point, to 6), then return to 9 (which move counts one point, or five points moved) and move upward four more points, to 5. The record stands 2, 6, 5, or 265.

29. Problems for Subtraction:

1. 86 − 34.
2. 79 − 45.
3. 59 − 46.
4. 88 − 57.
5. 96 − 63.
6. 347 − 316.
7. 794 − 432.
8. 927 − 715.
9. 2468 − 1205.
10. 7939 − 4615.
11. 72 − 34.
12. 61 − 46.
13. 85 − 39.
14. 78 − 59.
15. 94 − 77.
16. 365 − 72.
17. 546 − 284.
18. 798 − 645.
19. 916 − 438.
20. 723 − 536.
21. 1462 − 786.
22. 3794 − 1918.
23. 6890 − 4972.
24. 12612 − 7810.
25. 25604 − 6598.
26. 68509 − 18637.
27. 90460 − 42300.
28. 185640 − 38426.
29. 210800 − 175050.
30. 238641 − 212968.

MULTIPLICATION.

30. Multiply the figure in the highest order of the multiplicand by the figure in the highest order of the multiplier, and record the result on the fingers, leaving as many fingers to the right of the record as there are figures to the right of the two figures multiplied together. If the result exceeds nine, record the tens on the finger representing the next higher order.

Multiply the next lower figure of the multiplicand by the same figure, recording the result and carrying the tens in the same manner as before.

Continue until the entire multiplicand has been multiplied by the figure in the highest order of the multiplier.

Multiply the entire multiplicand, in the same manner as above, by the figure in the order next to the highest order in the multiplier, recording the results by adding them to that already recorded.

Continue multiplying by the next lower order of the multiplier until the multiplicand has been multiplied by the figure in units place in the multiplier, at which time the result is recorded on the hand.

31. Illustration 9:

Multiply 27 by 34.

Three times 2 =6. As there is one figure to the right of each of these figures, two fingers must be left to the right of the record. It must therefore be recorded on the second finger. (Record 600.)

Three times 7 =21. As there is one figure to the right of 3 and none to the right of 7, there must be one finger to the right of the record. It must therefore be recorded on the third finger. As 21 cannot be recorded, the 2 (which is really two tens of that order) is added to the 6 already recorded on the second finger. (Record 810.)

Four times 2 =8. As there is one figure to the right of

the 2 and none to the right of the 4, there must be one finger to the right of the record. It must therefore be added to the record on the third finger. (Record 890.)

Four times 7 = 28. As there is no figure to the right of either the 4 or 7, the 8 must be recorded on the fourth finger and the two added to the third finger as above. This makes the record on the third finger more than nine, so the tens must be carried to the second finger and added there. (Record 918.)

32. The above problem may be illustrated as follows:

Multiply 27 by 34.

		Record
3 times 2 = 6.	Record on the second finger.	600.
3 " 7 = 21.	" " " third "	810.
4 " 2 = 8.	" " " third "	890.
4 " 7 = 28.	" " " fourth "	918.

NOTE 11.—From the above it will be seen that this is ordinary multiplication, beginning with the higher orders instead of the lower, and recording on the fingers instead of paper or blackboard.

33. Illustration 10:

Multiply 346 by 67.

		Record
6 times 3 = 18.	Record on the first finger.	18000.
6 " 4 = 24.	" " " second "	20400.
6 " 6 = 36.	" " " third "	20760.
7 " 3 = 21.	" " " second "	22860.
7 " 4 = 28.	" " " third "	23140.
7 " 6 = 42.	" " " fourth "	23182.

34. Illustration 11:

Multiply 486 by 397.

		Record
3 times 4 = 12.	Record on the thumb.	120000.
3 " 8 = 24.	" " " first finger.	144000.
3 " 6 = 18.	" " " second "	145800.

			Record
9 times	4 = 36.	Record on the first finger	181800.
9 "	8 = 72.	" " " second "	189000.
9 "	6 = 54.	" " " third "	189540.
7 "	4 = 28.	" " " second "	192340.
7 "	8 = 56.	" " " third "	192900.
7 "	6 = 42.	" " " fourth "	192942.

35. Illustration 12:

Multiply 3642 by 68.

			Record
6 times	3 = 18.	Record on the thumb.	180000.
6 "	6 = 36.	" " " first finger.	216000.
6 "	4 = 24.	" " " second "	218400.
6 "	2 = 12.	" " " third "	218520.
8 "	3 = 24.	" " " first "	242520.
8 "	6 = 48.	" " " second "	247320.
8 "	4 = 32.	" " " third "	247640.
8 "	2 = 16.	" " " fourth "	247656.

36. Illustration 13:

Multiply 897 by 964.

			Record
9 times	8 = 72.	Record 22 on thumb.	
		(Drop 50. Remember 2. Note 12.)	[2]220000.
9 "	9 = 81.	Record on first finger.	
		(Add 8 to 22 on thumb = 30.	
		Drop 25 = 5. Remember 3.)	[3]51000.
9 "	7 = 63.	Record on the second finger.	57300.
6 "	8 = 48.	" " " first "	105300.
6 "	9 = 54.	" " " second "	110700.
6 "	7 = 42.	" " " third "	111120.
4 "	8 = 32.	" " " second "	114320.
4 "	9 = 36.	" " " third "	114680.
4 "	7 = 28.	" " " fourth "	114708.

The record on the thumb is 11. To this must be added 3 times 25, or 75. This makes the record 86 for the thumb. The result then is 864708.

NOTE 12.—As only twenty-five can be recorded on the thumb, it will be necessary to drop the twenty-five whenever the tens of thousands are greater than that. Call the twenty-five dropped one (which means once twenty-five) and remember it. Record the remainder on the thumb. By thus retaining 1, 2 or 3 in the memory, any numbers whose product does not exceed one million can be multiplied.

37. Problems for multiplication:

1. 32×3.
2. 24×2.
3. 12×4.
4. 231×4.
5. 121×4.
6. 26×4.
7. 58×7.
8. 89×7.
9. 136×8.
10. 347×7.
11. 23×16.
12. 47×32.
13. 68×34.
14. 75×86.
15. 96×98.
16. 135×62.
17. 386×39.
18. 434×73.
19. 862×86.
20. 1346×26.
21. 1347×34.
22. 2130×34.
23. 5068×76.
24. 3900×49.
25. 736×624.
26. 438×623.
27. 125×234.
28. 236×362.
29. 678×739.
30. 865×675.
31. 2346×7.
32. 6057×4.
33. 7892×9.
34. 4906×8.
35. 34528×5.
36. 49373×9.
37. 898×792.
38. 961×953.
39. 928×904.
40. 997×988.

MENTAL MULTIPLICATION.

38. Students should be able to multiply all numbers below one hundred mentally. They can learn to do this and do it in much less time than they can learn the multiplication table to twenty-five.

To multiply two numbers of two figures each, multiply the tens together and call the result hundreds; multiply the tens of each number by the units of the other number, calling the results tens, and add them to the hundreds; multiply the units together, calling the result units, and add it to the result obtained above. This final sum is the product of the numbers multiplied.

39. Illustration 14:

Multiply 68 by 76.

$7\times6=42$. Call this hundreds.
$7\times8=56$. Call this tens.
Add and read by business method (p. 15) $=47,60$.
$6\times6=36$. Call this tens.
Add and read by business method $=51,20$.
$8\times6=48$. Call this units.
Add and read by business method $=51.68$ or 5168.

40. Illustration 15:

Multiply 97 by 82.

$8\times9=72$ (hundreds).
$8\times7=56$ (tens). Add $=77,60$.
$9\times2=18$ (tens). Add $=79,40$.
$7\times2=14$ (units). Add $=79,54$ or 7954.

NOTE 13.—This process is the same as multiplying on the fingers, but the partial results are retained in the memory instead of being recorded on the hand, thus making it mental instead of manu-mental.

DIVISION.

41. Record the dividend on the left hand; remember the divisor.

Find how many times the divisor is contained in the fewest left figures of the dividend. (This quotient figure may be recorded on the thumb or any finger, regardless of its order, not in use. When all are employed it must be retained by memory. Multiply each figure of the divisor by this quotient figure and subtract the results from the dividend figures used above.

Using this remainder and the unused figures of the dividend as a new number, divide as before and record the result on the finger next to the one on which the previous result was recorded.

Continue this division until the remaining part of the dividend is less than the divisor, at which time both quotient and remainder will be recorded on the fingers or retained in the memory.

NOTE 14.—If in any division the quotient figure is made less than it should be, the remainder will be greater than the divisor; in which case it is not necessary to perform the operation again, as the error may be corrected by increasing the last quotient figure one, and subtracting the divisor from this last remainder. This may be done several times; or the quotient figure may be increased 2, 3, or 4 and two, three or four times the divisor may be subtracted.

NOTE 15.—At first much memory will seem necessary, but practice will soon develop this so the average student can perform operations which will appear marvelous to the uninitiated.

42. Illustration 16:

Divide 423 by 8.

Record 423 in left hand.

$42 \div 8 = 5$. Record this on thumb.

$5 \times 8 = 40$.

40 from 42 = 2 remainder. Recorded on third finger.

$23 \div 8 = 2$. Record this on first finger.

$2 \times 8 = 16$.

16 from $23 = 7$ remainder. Recorded on fourth finger.

Then the record stands complete, with 52, recorded on the thumb and first finger (without regard to order) and 7 recorded on the fourth finger. As 7 is the remainder and 8 is the divisor the result is $52\frac{7}{8}$.

43. Illustration 17:

Divide 382 by 16.

$38 \div 16 = 2$. Record on thumb.

$2 \times 1 = 2$. Subtract this from 3, which leaves 1.

2 times $6 = 12$. Subtract this from 1 and 8, or 18, which leaves 6.

$62 \div 16 = 3$. Record on the first finger.

3 times $1 = 3$. Subtract from 6, which leaves 3.

3 times $6 = 18$. Subtract from 3 and 2 or 32, which leaves 14. Then the record shows 2 and 3, or 23 with 14 remainder $= 23\frac{14}{16} = 23\frac{7}{8}$.

NOTE 16.—Where the divisor is 39, 57, 86, etc., use the next higher order of tens (or hundreds), 40, 60, 90, respectively, as the trial divisor for obtaining the quotient figure. If the quotient figure thus found is too small, it is easy to correct the error by the method shown in Note 14 and Illustration 18, but if the quotient figure is too large the operation must be performed again.

44. Illustration 18:

Divide 4698 by 69.

69 = nearly 70. (See note 16.)

$46 \div 7 = 6$. Record on thumb.

Multiply quotient figure by divisor.

6 times $6 = 36$. Subtract from 46 (recorded on 1st and 2nd fingers) and 10 remains (1st and 2nd fingers).

6 times $9 = 54$. Subtract from 109 (1st, 2nd and 3rd fingers) and 55 remains (2nd and 3rd fingers).

As the remainder, 55, is not equal to the divisor, 69, the quotient figure, 6, must be correct.

$55 \div 7 = 7$. Record on 1st finger.

7 times $6 = 42$. Subtract from 55 (2nd and 3rd finger) and 13 remains (2nd and 3rd finger).

7 times $9 = 63$. Subtract from 138 (2nd, 3rd, and 4th fingers) and 75 remains. (3rd and 4th fingers.)

Result, 67 with a remainder of 75.

As the remainder (75) is greater than the divisor (69), it is evident that the last quotient figure is not large enough. Correct the error by adding 1 to the last figure of the quotient ($7 + 1 = 8$) and subtracting once the divisor (69) form the remainder (75), leaving 6 for the remainder.

The final result is therefore 68 with 6 remainder or $68\frac{6}{69} = 68\frac{2}{23}$.

45. Illustration 19:

Divide 7642 by 37.

$76 \div 37 = 2$. Retain in memory.

$2 \times 37 = 74$. Subtract from $76 = 2$ remainder.

As 24 cannot be divided by 37, it is necessary to include the two additional orders before dividing again and the quotient obtained from this division must occupy two orders. As no quotient figure is more than 9, the second order must be filled with a naught.

$242 \div 37 = 6$. (Put a cipher before it and retain in memory.)

6 times $3 = 18$. Subtract from 24 (2nd and 3rd fingers) $= 6$.

6 times $7 = 42$. Subtract from $62 = 20$.

Result, 106 with 20 remainder or $106\frac{20}{37}$.

46. Illustration 20:

Divide 168482 by 338.

$1684 \div 338 = 4$. Remember.

4×338 subtract from $1684 = 332$.

$3328 \div 338 = 9$. Remember.

9×338 subtracted from $3328 = 286$.

$2862 \div 338 = 8$. Remember.

8×338 subtracted from $2863 = 158$.

Result 4, 9, 8, with 158 remainder, or $498\frac{158}{338}$, or $498\frac{79}{169}$.

47. Problems for division:

1. $83 \div 6$.
2. $93 \div 7$.
3. $49 \div 3$.
4. $168 \div 9$.
5. $725 \div 8$.
6. $871 \div 1$.
7. $687 \div 8$.
8. $482 \div 7$.
9. $3451 \div 8$.
10. $2789 \div 8$.
11. $7003 \div 2$.
12. $5675 \div 5$.
13. $8427 \div 9$.
14. $9304 \div 6$.
15. $735 \div 12$.
16. $865 \div 24$.
17. $658 \div 27$.
18. $469 \div 65$.
19. $352 \div 72$.
20. $105 \div 19$.
21. $4678 \div 26$.
22. $2576 \div 48$.
23. $3400 \div 93$.
24. $6075 \div 77$.
25. $3864 \div 61$.
26. $9007 \div 132$.
27. $6803 \div 365$.
28. $2345 \div 538$.
29. $5097 \div 960$.
30. $2045 \div 654$.
31. $23021 \div 6$.
32. $35680 \div 9$.
33. $97342 \div 34$.
34. $78623 \div 87$.
35. $60035 \div 136$.
36. $72038 \div 309$.
37. $30856 \div 568$.
38. $79832 \div 974$.
39. $58967 \div 2130$.
40. $98893 \div 8725$.

48. Review Problems:

1. I traveled in the train six days; the first day the train traveled 345 miles; the second, 294; the third, 332; the fourth, 367; the fifth, 392; and the sixth, 416. How far did I travel?

2. I bought three pieces of property: the first cost $3467; the second, $9688; the third, $325 more than both the first and second. How much did all cost?

3. On balancing my books at the end of the year, I find our firm has paid the following expenses: rent, $5786; light, $470; drayage, $1689; insurance, $950; fuel, $2306; clerk hire, $3875; sundries, $1962. The goods cost $32578 and sold for $64855. What is the firm's net gain or loss?

4. I bought 12 cows at $22 each, 4 horses at $65 each, 124 hogs at $7 each, and 38 sheep at $3 each. How much did I pay?

5. I sold 472 cattle at $46 a head. After depositing $8685 in the bank, I purchased a lot for $650, built a house on it for $9827 and bought 34 acres of land with the remainder. Find cost of one acre.

6. Sold four pieces of property for $3975, $6240, $12600 and $14485. I deposited one third of it in the bank and divided the remainder among my 5 children. How much did each receive?

7. I exchanged 13 barrels of molasses, each containing 32 gallons, at 50 cents per gallon, for 25 bolts of cotton worth 8 cents a yard. Find how many yards in a bolt.

DECIMALS.

49. In notation and numeration of decimals, the hand is used to keep the periods named and separated just as in notation and numeration of whole numbers. (Figs. 4 and 5.)

50. Notation of Decimals.

Write the decimal point and call it by the name of the denominator of the decimal fraction.

Place the left hand so the finger, which bears the name of the period in which the denominator is found, will be to the right of the decimal point, so the remaining orders of that period, if there are any, may be written between.

If the next lower order contains figure, other than zero, write the numerator of the fraction as a whole number.

If the next lower order contains no figure, other than zero, fill each place with a cipher until the highest order of the numerator is reached, then write the numerator as a whole number.

NOTE 17.—By this method of writing decimal fractions the decimal points, being written first, can be placed under each other and the decimal fractions written in position for adding or subtracting, and the student will grasp the idea of the decimal fraction much easier and be able to handle it much more readily than he will when compelled to write the numerator as a whole number, then begin with "tenths" (at "units") and enumerate to the left, filling vacant places with ciphers, to place the decimal point.

51. Write:

1. Seven hundredths.
2. Twenty-eight hundredths.
3. Thirty-five thousandths.
4. Four hundred five thousandths.
5. Nine thousandths.
6. Seven hundred two ten-thousandths.
7. Ninety-five millionths.
8. Seven thousand four hundred sixty-eight trillionths.

FIG. 4.

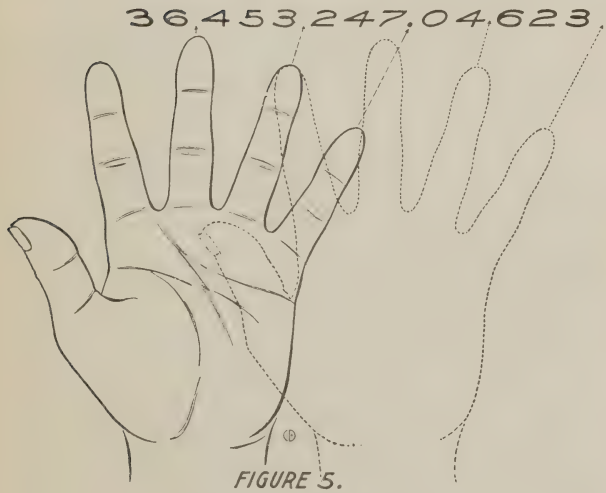


FIGURE 5.

DECIMALS.

9. Eighty-seven ten-millionths.

10. Three hundred fifty seven hundred-millionths.

11. One million seven hundred thousand sixty-nine ten-billionths.

12. Three hundred sixty thousand two hundred three millionths.

13. Eighty-eight and five thousand five hundred-thousandths.

14. Seven, and seventy-five thousand five hundred-thousandths.

15. Three hundred six, and thirty-five ten-thousandths.

16. Forty thousand seventy-six, and twelve hundred-thousandths.

17. Six, and one thousand six hundred forty-two ten-millionths.

18. Thirty-seven, and thirty-seven thousandths.

19. Twenty-five million, and twenty-five millionths.

20. Six hundred thirty thousand, and sixty-three thousandths.

52. Numeration of Decimals:

To read a decimal fraction place the hand beneath the fraction, so the fourth finger will come to the right of the "units" and the third finger so three orders will come between it and the fourth finger, etc. (Fig. 4.) Read the figures of the fraction as if they were a whole number, then call the denomination by the order which the decimal occupies, adding "ths" (hundred, hundredths, etc.). To read a whole number and decimal: Read the whole number, then move the hand as in Fig. 5 and read the decimal.

Note 18.—In this method the decimal point is considered as occupying an order just as a figure does. It is not necessary to "numerate from the decimal point" nor to "begin with the right hand figure and call it tenths" to numerate s read the decimal fraction.

53. Read:

1. .0047
2. .3406
3. 9.326
4. 25.0003407
5. 9230010.04
6. .00000300007
7. 3708.9200700006
8. 200000.000002
9. 700800.800007
10. $.003\frac{3}{7}$
11. $400.73\frac{2}{3}$
12. 6.0035782
13. $.000\frac{5}{9}$
14. $.6007\frac{2}{3}$
15. 58774862.57915060
16. 8005076000.005000347705
17. 3794.0000005789456
18. .000000000475603
19. 2876435.0042001056783
20. 479346783257862.56791132782462

54. Addition of Decimals:

Decimals may be added as whole numbers are added.

In adding numbers that contain both whole numbers and decimals, it is well to spread the fingers between which the decimal point should come and use each finger to represent an order (Figs. 6, 7, 8, 9.)

NOTE 19.—In reading and writing numbers, the fingers are spread and may cover five periods or fifteen figures; but in addition, subtraction, multiplication and division, the fingers are not spread and cover but five orders (five figures).

55. Subtraction of Decimals:

Remember the instruction for subtraction of whole numbers and apply the suggestion given under addition of decimals.

56. Multiplication of Decimals:

Multiply, decimals just as whole numbers.

When two figures were multiplied together they were recorded on the fingers, leaving as many fingers on the right of the record as there were figures on the right of the figures multiplied together; so in multiplying decimals there will be as many figures to the right of the decimal point as there were to the right of both decimal points.

57. Division of Decimals:

Divide decimals just as whole numbers are divided.

Find the difference in the number of decimal places in the divisor and dividend. If those in the dividend exceed, point off that many decimals in the quotient; if those in the divisor exceed, add that many ciphers to the result.

NOTE 20.—In division of decimals by the ordinary method (with paper and pencil), when the divisor is multiplied by a figure of the quotient the decimal point should be placed in each result until it comes beneath the decimal point in the dividend, at which time the decimal point should be placed in the quotient.

If the divisor is larger than the dividend, divide the fingers as in Figs. 6 to 9, to show the number of places in the divisor; place the hand beneath the dividend, with the opening between the fingers beneath the decimal point, at the same time placing the decimal point in the quotient; move the hand to the right, placing a cipher in the quotient each time the hand is moved one order, until the divisor may be subtracted from the figures in the dividend directly above it, and then divide as in whole numbers. Many students who seem unable to understand division of decimals will become prompt and accurate by this method.

FIG. 6.

FIG. 7.

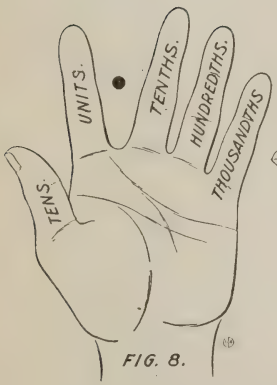


FIG. 8.

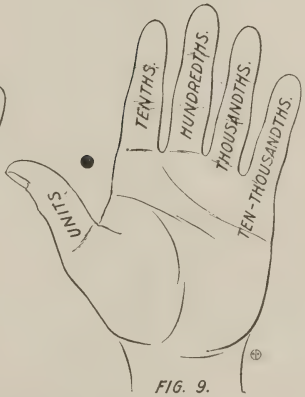


FIG. 9.

DECIMALS.

58. Problems for Addition of Decimals:

1.

.075
.308
.57

2.

.037
.0469
.3278
.0598

3.

.00653
.0398
.6372
.57503
.78932

4.

.457
.2587
.3698
.0598

5.

.00005
.03
.6007
.4603
.90876
.0057
.0003

6.

3.25
20.3
35.68
78.05
125.7

7.

2.205
3.065
9.12
4.
7.653
6.003
3.07

8.

1.0003
4.7006
5.04
2.057
3.1028

9.

128.79
346.3
721.8
35.25
60.32
9.4

10.

10.
13.1
7.4
136.9
230.
416.3
350.4
38.7

59. Problems for Subtraction of Decimals:

1. .784 − .036
2. .58 − .026
3. .7432 − .065
4. .2879 − .0934
5. .4 − .0349
6. 4.25 − 2.06
7. 12 − 9.95
8. 120 − .012
9. 1.005 − .697
10. 3.016 − 2.697

60. Problems for Multiplication of Decimals:

1. 2.6 × 7
2. .39 × 1.5
3. .07 × .34
4. 7.8 × 34
5. .78 × .34
6. 26.35 × 17
7. 30.4 × .26
8. 13.4 × 26
9. 6.238 × .4
10. 12.5 × .006
11. 130 × .072
12. .325 × 680
13. 75.8 × 12
14. 3.47 × 203
15. 20.5 × .036
16. 378 × 1.034
17. 622 × .006
18. 70.3 × .00009
19. 90000 × .0065
20. .0004 × .2648
21. 5.065 × 68
22. .127 × 35
23. .054 × 43
24. .00075 × 7.38
25. .0412 × .00027
26. 27 x 2.7 × .27
27. .15 × 15 × .015
28. 7 × 76 × .706
29. .018 × .034 × .047
30. 46 × 4.06 × 4.6

61. Problems for Division of Decimals:

1. 43.60 ÷ 52
2. 9.68 ÷ 6.4
3. .065 ÷ 78
4. .05475 ÷ 15
5. .11928 ÷ .056
6. .04905 ÷ 237
7. .00594 ÷ .039
8. 126.54 ÷ 7.03
9. 1.2288 ÷ 51.03
10. 190 ÷ .038
11. 46 ÷ .0004
12. .46 ÷ 40
13. 4.6 ÷ 4
14. 164 ÷ 2.05
15. .0027 ÷ 67.5
16. .00065 ÷ .8125
17. .0683 ÷ .009
18. 81 ÷ 4.05
19. .016 ÷ 160
20. .20002 ÷ 400.04

CASTING OUT THE NINES.

62. The student should test results by casting out the 9s. This is not a positive test. It will not indicate an error of nine or any multiple of nine, but it will indicate any other error, and is therefore valuable.

Every number has a "test figure." It is obtained by casting out the 9s. This is done in two ways: 1st, by adding the digits and dividing by 9; the remainder is the test figure: 2d, by adding the digits together continuously until the result has but one figure in it.

63. Illustration 21:

Find the test figure for 346. Add $3+4+6=13$. Divide by $9=1$ with 4 remainder. The remainder 4 is the test figure.

64. Illustration 22:

Find the test figure of 4867. Add $4+8+6+7=25$. Divide by $9=2$, with 7 remainder. 7 is the test figure.

65. Illustration 23:

In the above illustration, the 9s may be dropped at any time as follows:

Find the test figure for 4867. Add $4+8=12$. (As this is more than 9, subtract 9 from it). $12-9=3$. $3+6=9$. $9-9=0$. $0+7=7$. 7 is the test figure.

66. Illustration 24: (Second method.)

Find test figure for 176. Add $1+7+6=14$.

Add these digits together. $1+4=5$. 5 is the test figure.

67. Illustration 25:

Find the test figure for 6879467. Add $6+8+7+9+4+6+7=47$. $4+7=11$. $1+1=2$. 2 is the test figure.

68. To test addition by casting out the 9s, find the test figure for each number, then find the test figure for these figures. If the test figure for the sum is the same, the addition is correct unless a mistake of 9 or some multiple of 9 has been made.

69. Illustration 26:

Add.	Test figure:
426	3
347	5
819	0
240	6
674	8
2506	22

$2+5+0+6=13$. $1+3=4$. Test figure.
$2+2=4$. Test figure.

70. To test subtraction by casting out the 9s, subtract the test figure of the subtrahend from the test figure of the minuend. The result will be the test figure of the remainder.

If the test figure of the minuend is smaller than the test figure of the subtrahend, add 9 to it and subtract.

71. Illustration 27:

Subtract.	Test figures.	
4732	$16=7$.	
3684	$21=3$.	
1048	4.	Test figure
$1+0+4+8=13=4$.		Test figure.

72. Illustration 28:

Subtract.	Test figures.	
78409	$28=10=1$.	As 2 cannot be subtracted
47693	$29=11=2$.	from 1, add 9 to the 1,
30716.		which makes 10. Subtract 2 from 10, which equals 8. Test figure is 8.

$3+0+7+1+6=17=8$. Test figure.

73. To test multiplication by casting out the 9s, find the test figure for the multiplier, and for the multiplicand. Multiply these together. The test figure of this result will be the same as the test figure of the product of the multiplier and multiplicand.

74. Illustration 29:

Multiply.	Test figures.
137	11 = 2.
42	= 6.
5754	12.

5754 = 21 = 3.

12 = 3. Then the product is probably correct.

75. To test division by casting out the 9s, multiply the test figure of the quotient by the test figure of the divisor and add the test figure of the remainder. The result will be the test figure of the dividend.

76. Illustration 30:

Divide 4623 by 5.

5)4623—15 = 16. Test figure.

924—3 remainder.

5 × 6 = 30. 30 + 3 = 33 = 6. Test figure.

77. Illustration 31:

Divide 3416 by 23.

23)3416(148. Test figure 4.

23	23. Test figure is 5.
111	3416. Test figure is 5.
92	4 × 5 = 20. 20 + 3 = 23 = 5.
196	Test figure.
184	
12.	Test figure is 3.

UNITED STATES MONEY.

78. In problems containing dollars and cents, spread the second and third fingers (Fig. 7). The opening between them will represent the decimal point. Record the dollars on the thumb, first and second fingers. If problems contain dollars only, use the fingers as in whole numbers.

To reduce dollars and cents to cents, close the opening between the second and third fingers and the record is cents.

To reduce cents to dollars, make an opening between the second and third fingers and the record is dollars and cents.

79. Problems in United States Money.

1.	Add:	\$134.20, \$75, \$68.30.
2.	"	\$2460, \$4725, \$396.
3.	"	\$46.35, \$47.80, \$265.60.
4.	"	\$125.35 \$78.93, \$734.60.
5.	"	\$34.95, \$47.86, \$79.65.
6.	Subtract:	\$76.85 from \$285.20.
7.	"	\$92.47 " \$107.
8.	"	\$17.87 " \$32.60.
9.	"	\$34.40 " \$67.95.
10.	"	\$76 " \$134.20.
11.	Multiply:	\$32.26 by 6.
12.	"	\$9.47 by 15.
13.	"	\$18.65 by 46.
14.	"	\$.75 by 132
15.	"	\$3238.60 by 7.
16.	Divide:	\$8.37 by 16.
17.	"	\$78.60 by 30.
18.	"	\$2647 by 36.
19.	"	\$147.80 by 127.
20.	"	\$9 by 27.

NOTE 21.—In problems like the 15th, multiply the cents first, remembering the result, then use all the fingers in multiplying the dollars.

NOTE 22.—Canadian money is treated just the same as United States money is treated.

FRENCH MONEY.

80. French money is used in Switzerland and Belgium. The lira of Italy, peseta of Spain, drachma of Greece, and the bolivar of Venezuela are the same as the franc (19.3c).

To reduce francs to dollars of United States money multiply by .193; or for approximate value divide by 5.

To reduce dollars to francs divide by .193; or for approximate value multiply by 5.

81. Problems in French Money:

1. Add:	fr.	d.	c.	m.
	30	7	4	0
	13	0	6	5
	8	8	7	8
	25	7	0	6
2. "	fr.	d.	c.	m.
	10	3	4	0
	8	7	9	6
	15	2	0	7
	20	7	6	3
3. Subtract:	fr.	d.	c.	m.
	12	6	3	4
	6	8	2	9
4. "	fr.	d.	c.	m.
	38	0	0	6
	16	7	9	8
5. "	fr.	d.	c.	m.
	76	0	0	0
	38	7	3	5

6. Multiply: 7fr. 3d. 0c. 7m. by 9.
7. " 2fr. 0d. 8c. 7m. " 16.
8. " 135fr. 4d. " 24.
9. Divide: 17fr. 4d. 6c. by 7.
10. " 135fr. 2d. " 28.
11. Reduce: $25.00 to francs (exact).
12. " $30.40 " " " "
13. " $120.00 " " (approximate).
14. " $78.35 " " "
15. " $9.65 " " "

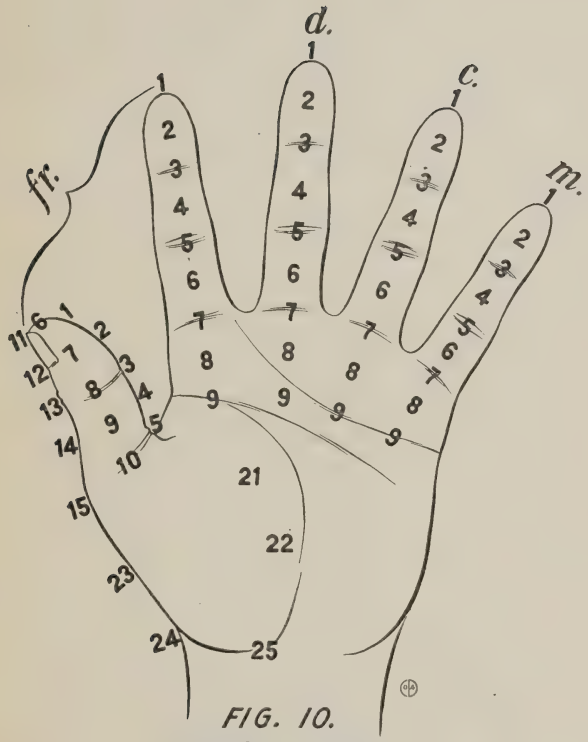


FIG. 10.
FRENCH MONEY.

ENGLISH MONEY.

82. To reduce £ to $, multiply by 4.8665, or for approximate value multiply by 5.

To reduce $ to £, divide by 4.8665, or for approximate value divide by 5.

83. Problems in English Money.

1. Add:

£	s.	d.	far.
12	14	7	2
20	10	3	1
16	18	4	3
8	0	9	0

2. "

£	s.	d.	far.
35	16	11	3
20	10	5	1
8	15	7	2
6	4	0	3

3. Subtract:

£	s.	d.	far.
25	9	10	2
12	19	4	2

4. "

£	s.	d.	far.
146	3	6	2
68	9	3	3

5. "

£	s.	d.	far.
216	0	0	0
187	13	7	2

6. Multiply: £6 4s. 6d. 3far. by 7.
7. " £4 17s. 4d. 2far. by 24.
8. " 9s. 6d 3far. by 137.
9. Divide: £26 3s. 10d. 2far. by 7.
10. " £135 7d. by 16.
11. Reduce: £12 14s. 2far. to far.
12. " £120 10s. to d.

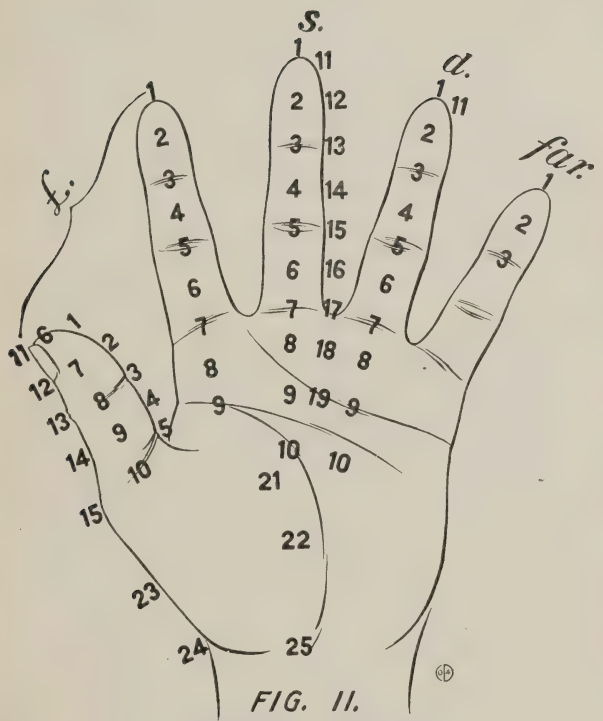


FIG. II.
ENGLISH MONEY.

13. Reduce: 240d. to £ s. d.
14. " 646d. to £ s. d.
15. " 785far. to integers.
16. " 385s. to £.
17. " 1580d. to integers.
18. " 6430far. to integers.
19. " 620far. to s.
20. " 135s. to £.
21. " £8 to $ (exact).
22. " £5 " $ "
23. " £10 " $ "
24. " £120 " $ (approximate).
25. " £34 " $ "

GERMAN MONEY.

84. 100 pfennigs make one mark (Reichsmark).

For German money use the hand the same as in U. S. money. The thumb, 1st and 2d fingers represent marks, while the 3d and 4th fingers represent pfennigs.

The mark is equal to 23.8 c. in U. S. money.

To reduce $ to M. divide by 23.8, or for approximate value divide by 5 and add $\frac{1}{5}$ of the result to it.

To reduce M. to $, multiply by 23.8, or for approximate value divide by 5 and subtract $\frac{1}{5}$.

In rough estimates the Mark is considered 25c, or $\frac{1}{4}$$.

85. Problems in German Money:

1. Reduce: 8.24 M. to $ (approximate).
2. " 15 M. to $ "
3. " $9.20 to M. "
4. " $35 to M. "
5. " 7.34 M. to $ (exact).
6. " 30 M. to $ "
7. " $10.35 to M. "
8. " $28 to M. "

86. Review Problems:

1. What is the cost of a bill on Paris for 1346 francs?

2. What is the cost of a bill on Amsterdam for 3426 marks?

3. What is the cost of a bill on London for £12 10s.?

4. Bought 10,000 pounds of dressed beef at 8 cents per pound, shipped it to France at a cost of $250 and sold it at 8 decimes per pound. How many dollars did I gain?

5. Bought a bicycle in London for £5 and sold it in Madrid for 150 peseta. Did I gain or loose and how much, in United States money?

6. I can buy a suit of clothes for 45 francs in Paris, £2 in London, 33 marks in Berlin or $28 in New York. Which is the cheapest place to buy it and how much cheaper than each of the other places is it?

7. I traveled in Europe last summer, spending $75 for steamer, etc., £40 5s. in England, 325 francs in France and Switzerland, and 116 marks 50 pfennigs in Germany. How much did my trip cost me?

8. I had $1200 when I left New York. I spent $\frac{1}{12}$ of it in London, $\frac{1}{3}$ in Germany, $\frac{1}{6}$ in Belgium, $\frac{1}{24}$ in Italy and $\frac{1}{8}$ in Switzerland. How much, in native coin, did each country receive?

9. A German owes an Englishman 20 marks, he gives an order on a Frenchman for 15 francs and pays the rest of the debt in English money. How much English money does he pay?

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DRY MEASURE.

87. Problems:

1. Add:

bu.	pk.	qt.	pt.
12	3	7	1
13	2	3	1
68	2	0	1
37	0	6	0

2. "

bu.	pk.	qt.	pt.
10	2	5	0
6	3	4	1
5	2	0	0
3	0	0	1

3. Subtract:

bu.	pk.	qt.	pt.
12	3	7	1
8	1	5	0

4. "

bu.	pk.	qt.	pt.
120	2	3	0
34	3	7	1

5. "

bu.	pk.	qt.	pt.
245	0	0	0
198	3	6	1

6. Multiply: 35 bu. 2 pk. 4 qt. 1 pt. by 7.
7. " 16 bu. 3 pk. 6 qt. by 18.
8. Divide: 28 bu. 2 pk. 7 qt. 1 pt. by 4.
9. " 125 bu. 3 pk. 2 qt. 1 pt. by 235.
10. " 76 bu. 2 pk. 5 qt. by 235.

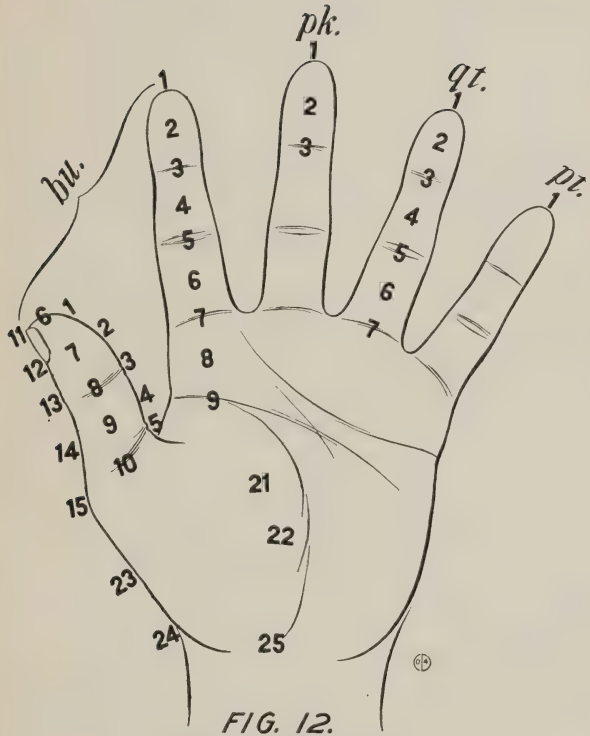

FIG. 12.
DRY MEASURE.

LIQUID MEASURE.

88. Problems:

1. Add:

brl.	gal.	qt.	pt.	gi.
2	15	2	1	2
3	18	0	1	3
1	28	3	0	3
2	5	1	1	0

2. "

brl.	gal.	qt.	pt.	gi.
4	7	2	1	1
3	30	0	1	0
1	31	2	1	3
5	2	3	1	2
2	0	3	0	1

3. Subtract:

brl.	gal.	qt.	pt.	gi.
5	18	3	1	3
1	7	2	1	2

4. "

brl.	gal.	qt.	pt.	gi.
16	7	2	0	1
4	8	0	1	3

5. "

brl.	gal.	qt.	pt.	gi.
9	0	0	0	0
2	26	2	1	2

6. Multiply: 2 brl. 7 gal. 2 qt. 1 pt. 3 gi. by 4.
7. " 5 brl. 12 gal. 3 qt. 2 gi by 35.
8. Divide: 4 brl. 3 gal. 3 qt. 1 pt. 2 gi. by 7.
9. " 15 brl. 26 gal. 3 qt. 1 gi. by 18.
10. " 29 brl. 24 gal. 2 qt. 1 pt. 3 gi. by 46.

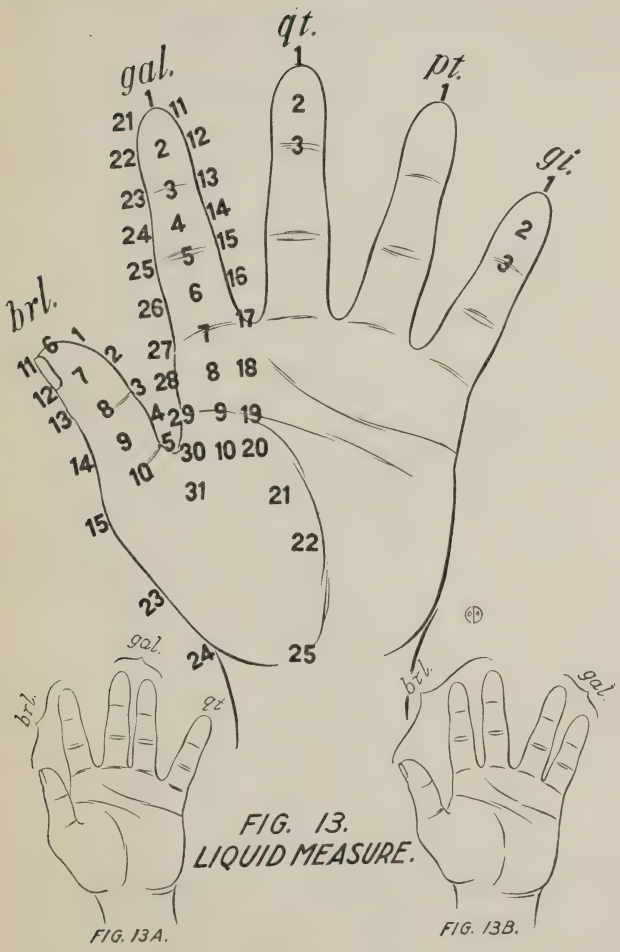

FIG. 13.
LIQUID MEASURE.

FIG. 13A.

FIG. 13B.

APOTHECARY WEIGHT.

89. Problems:

1. Add:	℔	℥	ʒ	℈	gr.
	3	5	4	2	7
	6	9	2	1	12
	4	11	6	1	17
	2	7	3	2	5
2. "	℔	℥	ʒ	℈	gr.
	4	0	3	1	6
	5	7	2	0	8
	3	5	0	2	14
	3	6	0	2	0
	5	10	3	1	16
3. Subtract:	℔	℥	ʒ	℈	gr.
	12	6	4	2	7
	8	3	2	1	4
4. "	℔	℥	ʒ	℈	gr.
	10	9	2	0	6
	4	3	5	2	3
5. "	℔	℥	ʒ	℈	gr.
	22	0	6	3	4
	7	3	7	0	16
6. "	℔	℥	ʒ	℈	gr.
	13	0	0	0	0
	2	6	7	1	18

7. Multiply: 33 ℔. 6 ℥ 4 ʒ 1 ℈ 2 gr. by 6.
8. " 2 ℔. 0 ℥ 7 ʒ 2 ℈ 15 gr. by 26.
9. Divide: 4 ℔. 7 ℥ 3 ʒ 1 ℈ 10 gr. by 26.
10. " 8 ℔. 7 ℥ 6 ʒ 2 ℈ 14 gr. by 25.

FIG. 14.
APOTHECARY WT.

AVOIRDUPOIS WEIGHT.

90. Reduce pounds to T., cwt, lb. Record the pounds on the fingers; spread the first and second, and the second and third fingers (Fig. 16). Divide the number recorded on the thumb and first finger by two. If there is a remainder carry it to the next finger, where it will add 10 to the record:

91. Problems.

1. Reduce: 15478 lb. to T., cwt., lb.
2. " 26475 lb. to T., cwt., lb.
3. " 5 T., 16 cwt., 75 lb. to lb.
4. " 65 T., 3 cwt. to lb.
5. " 6543 lb. to ounces.
6. " 3 T. 12 cwt., 3 qr., 6 lb., 10 oz. to oz.
7. " 28930 oz. to integers.

8. Add

T.	cwt.	qr.	lb.	oz.
3	9	0	20	12
2	18	2	23	8
3	5	2	20	7
5	2	1	16	14

9. Subtract:

T.	cwt.	qr.	lb.	oz.
8	6	3	22	7
2	3	1	9	5

10. "

T.	cwt.	qr.	lb.	oz.
12	2	1	5	9
4	14	2	17	14

11. Multiply: 2 T. 7 cwt. 1 qr. 16 lb. 5 oz. by 5.
12. " 1 T. 16 cwt. 3 qr. 10 lb. 3 oz. by 36.
13. Divide: 2 T. 7 cwt. 1 qr. 20 lb. 10 oz. by 6.
14. " 5 T. 16 cwt. 3 qr. 7 lb. 10 oz by 34.

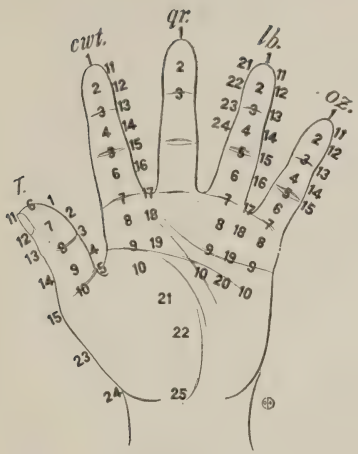

FIG. 15.
AVOIRDUPOIS WT.

FIG. 15.
AVOIRDUPOIS WT.

TROY WEIGHT.

92. Problems:

1. Add:

lb.	oz.	pwt.	gr.
17	7	16	22
4	8	6	10
3	5	7	12
7	10	19	6

2. "

lb.	oz.	pwt.	gr.
7	0	4	17
10	6	4	12
3	0	16	4
2	9	14	31

3. Subtract:

lb.	oz.	pwt.	gr.
135	10	18	21
67	8	9	14

4. "

lb.	oz.	pwt.	gr.
86	2	4	12
62	8	14	23

5. "

lb.	oz.	pwt.	gr.
76	0	0	0
25	10	4	14

6. Multiply: 8 lb. 4 oz. 7 pwt. 12 gr. by 8.
7. " 16 lb. 9 oz. 14 pwt. 17 gr. by 23.
8. Divide: 7 lb. 4 oz. 16 pwt. 4 gr. by 7.
9. " 18 lb. 8 oz. 10 gr. by 35.
10. " 135 lb. by 246.

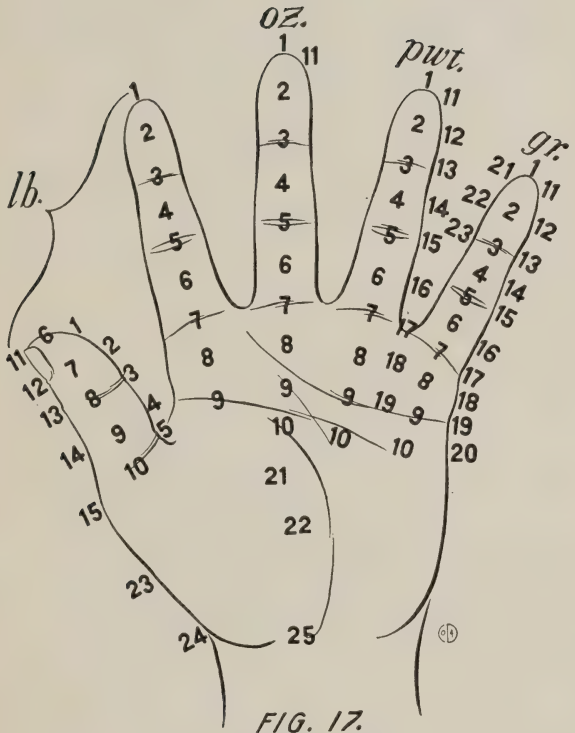

FIG. 17.
TROY WT.

LONG MEASURE.

93. In most practical problems in Long Measure, the higher numbers, miles and rods, or the lower numbers, rods, yards, feet and inches, are used. In either case one or the other hand will answer. (Figs. 18 and 19.)

In yards record the half on side of finger.

94. Problems in Long Measure:

1. Add:

rd.	yd.	ft.	in.
26	2	1	7
6	4	2	9
3	2	0	3
12	5	2	11

2. "

mi.	rd.
12	120
24	72
35	307
11	135

3. "

mi.	rd.	yd.	ft.	in.
12	160	2	1	7
3	132	4	2	8
12	247	0	1	10
3	78	5	2	6

4. Subtract:

mi.	rd.
32	27
8	130

5. "

rd.	yd.	ft.	in.
26	2	2	8
16	4	2	10

6. "

mi.	rd.	yd.	ft.	in.
12	18	2	1	6
4	35	5	2	9

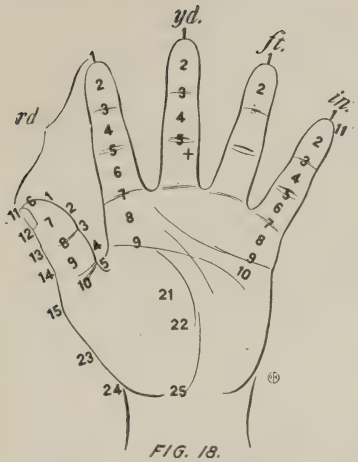

FIG. 18.
LONG MEASURE.

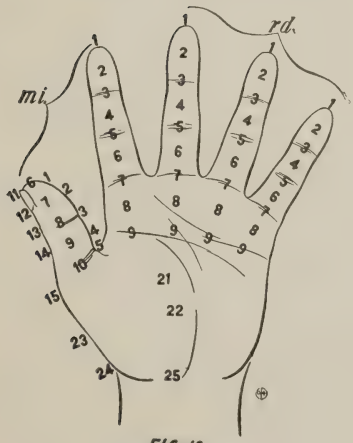

FIG. 19
LONG MEASURE.

7. Multiply: 7 rd. 4 yd. 2 ft. 8 in. by 7.
8. " 3 rd. 2 yd. 1 ft. 4 in. by 36.
9. " 6 mi. 147 rd. by 28.
10. " 4 mi. 65 rd. 4 yd. 2 ft. 7 in. by 9.
11. Divide: 7 rd. 4 yd. 1 ft. 6 in. by 7.
12. " 15 rd. 3 yd. 2 ft. 8 in. by 46.
13. " 4 mi. 235 rd. by 26.
14. " 2 mi. 116 rd. 2 yd. 1 ft. 8 in. by 9.

NOTE 23.—In problems like the third, sixth, tenth and fourteenth, either the higher or lower denomination must be remembered, as five fingers are not enough to record them on. If the student has been thoroughly drilled in the previous work, he can work these and all similar problems by the Manu-Mental process.

95. Review Problems:

1. I bought four pieces of cloth, 5 yd. 2 ft. 8 in.; 6 yd. 1 ft. 9 in.; 2 yd. 7 in., and 4 yd. 2 ft. 6 in., at 60c. per yd. How much did it cost?

2. Put a wire fence, consisting of three wires, around a field that is one-half mile long and one-fourth mile wide. The posts are $16\frac{1}{2}$ feet apart. How much did it cost if wire is worth 10c. per rod (staples furnished) and posts, cost 10c. each?

3. How much would it cost to carpet two rooms, 17 ft. by 21 ft. and 15 ft. by 25 ft., carpet running lengthwise and costing 70c. per yd.?

4. Which would cost the most and how much? To tile a hall 8 ft. by 20 ft. with tiles 4 in. by 4 in. costing 5c. per dozen or to carpet it (lengthwise) with body Brussels three-fourths yard wide at $1.25 per yd.?

5. I sell the oats in a bin 12 ft. by 6 ft. by 4 ft. at 22c. per bu. (Approx. $1\frac{1}{4}$ cu. ft. = 1 bu.) and invested the proceeds in molasses at 26c. per gallon. How many barrels and gallons did I buy?

6. Quinine costs $1.80 per oz. A pharmacist bought 3 lb. 8 oz. and sold it in 5 gr. doses at 10c. per dose. Find his gain.

7. Bought 65 lb. licorice at 20c. per pound avoirdupois and sold it at 28c. per pound apothecary weight. How much did I gain?

8. Bought a nugget which weighed three pounds (Av. Wt.) for $230. One-half of it was gold. I sold this to the mint (Troy Wt.) at $20 per oz. Did I gain or lose? How much?

9. A tank 8 ft. x 6 ft. x 12 ft. has 10 feet of water in it. How many gallons of water does it contain? (Approx. $7\frac{1}{2}$ gallons = 1 cu. ft.)

10. A tank 5 ft. x 7 ft. x 9 ft. on the inside is filled with water. The tank weighs 350 pounds Av. How much weight is there on the foundation? (Approx. 1 gallon weighs $8\frac{1}{3}$ pounds.)

11. A field produces 46 bu. 2 pk. 6 qt. of corn per acre. I sold the crop from 37 acres at 35 cents per bu. How much did I receive?

12. How many spoons can be made from 6 lb. 4 oz. 10 pwt. of silver if one spoon weighs 2 oz. 5 pwt.

13. I sell 6 T. 5 cwt. of coal at $6.50 per ton and buy flour at $4.75 per barrel. How many barrels do I get?

14. I put a bin of wheat into sacks and find I have 42 sacks of 2 bu. 1 pk. 2 qt. each. How much was in the bin?

15. I carry 65 lb. 12 oz. of coal in each bag. I deliver 30 bags when coal is $6 per ton. How much should I receive?

16. How many quinine pills of 3 gr. each can be made from 7 ℥ 4 ʒ 2 ℈?

THE CALENDAR.

96. To add any number of days to any date, add the number of days to the day of the month, divide by 30, the result will be months and days.

Count forward the number of months, subtract 1 day for each "joint" or "end" passed over and add one (for leap year) or two days if February is passed.

97. Illustration 32:

Add 135 days to Jan. 24.

$24+135=159$ from Jan. 1st.

$159\div30=5$ mo. $+9$ days.

Jan. $+5$ mo. 9 days = June 9.

As one end and two joints are passed over in the 5 months, 3 must be subtracted from the 9 days $=6$ days. As February is one of the months passed, add 2 days $=$ June 8. Therefore June 8 is 135 days later than Jan. 24.

98. Illustration 33:

Add 74 days to Feb. 6, 1904.

Feb. $6+74=$ Feb. 80th.

$80\div30=2$ mo. $+20$ days $=$ Apr. 20.

Feb. has 29 days, so subtract 1 = Apr. 19. Mar. is on a joint, so add 1 and the result is Apr. 20.

99. Illustration 34:

Oct. $16+138$ days.

Oct. $16+138=154$ days.

$154\div30=5$ mo. 4 da. = Mar. 4.

3 joints and ends are passed over, so subtract 3 days from Mar. 4 = Mar. 1.

Add 2 days for Feb. = Mar. 3.

100. To find the number of days between two dates, count the months on the fingers, multiply by 30, add 1 day for each joint or end passed over and subtract 1 or 2 for Feb., if it is one of the months completed. This gives the

FIG. 20.
CALENDAR.

number of days from the first date to the same day of the last month. If the given day of the last month is before this day, subtract their difference; if it is after, add their difference and the result will be the number of days between the two given dates.

101. Illustration 35:

Find the number of days from March 26 to July 15.

Mar. to July = 4 mo.

$4 \times 30 = 120$.

As 2 joints are passed over add 2.

$120 + 2 = 122$. This is the time to July 26.

$26 - 15 = 11$.

$122 - 11 = 111$. Number of days between March 26 and July 15.

102. Illustration 36:

Find the number of days from Jan. 18, 1904, to May 30, 1904.

4 mos. = 120.

1 joint and 1 end = 2.

$120 + 2 = 122$.

Feb. has 29 days, so subtract 1 day. $122 - 1 = 121$.

$30 - 18 = 12$.

$121 + 12 = 133$ days between Jan. 18 and May 30.

NOTE 24.—To find the number of months and days between two dates count them on the fingers. To find the date that is any number of months and days after a given date count forward that many months and add the days. The student will learn this method in a very short time.

103. Problems on the Calendar.

Find the number of days between

1. Jan. 7 and Apr. 25.
2. Mar. 27 and Oct. 3.
3. July 16 and Dec. 28.
4. Nov. 23 and May 3 (next year).
5. Dec. 26, 1903, and July 4, 1904.

Find the number of years, months, and days, between

6. Jan. 13 and Oct. 23, 1900.
7. July 26, 1902, and Dec. 4, 1904.
8. July 30, 1902, and Feb. 29, 1904.
9. Nov. 23, 1889, and Mar. 21, 1906.
10. July 4, 1776, and June 26, 1904.

Find date

11. 35 days after Jan. 15.
12. 178 days after Nov. 12.
13. 23 days after Dec. 31.
14. 137 days after Feb. 6.
15. 267 days after July 12.
16. 3 mo. 10 da. after Feb. 7, 1892.
17. 5 mo. 29 da. after June 30, 1896.
18. 2 yr. 5 mo. 15 da. after Sept. 23, 1901.
19. 7 yr. 19 da. after June 1, 1905.
20. 16 yr. 7 mo. 24 da. after Dec. 24, 1876.
21. How old are you in years, months, days?
22. I was born Jan. 10, 1870. How old was I July 4, 1904?
23. Two notes were given Oct. 1, 1903, one for 6 mo. 10 da. and the other for 190 da. Find when each is due.
24. Two notes were given Jan. 15, 1902, one for 2 mo. 5 da.; the other for 75 da. Find when each is due.
25. How many days since July 24, last?
26. A note was given Jan. 29, 1903, and paid July 3, 1904. How many days did it run?
27. A note was given June 21, 1903, and paid Mar. 2, 1904. How many days did it run?

INTEREST AND DISCOUNT.

104. Most practical problems in interest can be worked by the Manu-Mental Process. It is especially applicable to the Bankers' Method; *i. e.*, shift the decimal point two places to the left for the interest for 60 days at 6%, or three places for 6 days at 6%. For other times and rates use proportion or aliquot parts.

Bank discount is the same as simple interest. True discount is the amount which deducted would leave a sum which if placed on interest for the given rate and time would produce the amount of the note or bill discounted.

NOTE 25.—The point shifted two places to the left gives the interest for

180	days	at 2%	45	days	at 8%
120	"	3	40	"	9
90	"	4	36	"	10
72	"	5	30	"	12
60	"	6			

105. Problems in Interest and Discount:

1. \$200 at 6% 3 yr.
2. \$130 at 6% 1½ yr.
3. \$420 at 6% 1 yr. 9 mo.
4. \$750 at 6% 1 yr. 4 mo. 12 da.
5. \$300 at 8% 3 yr.
6. \$240 at 8% 2½ yr.
7. \$635 at 8% 1 yr. 3 mo.
8. \$145 at 4% 2 yr. 4 mo. 18 da.
9. \$60 at 5% 4 mo.
10. \$25.30 at 6% 18 da.
11. \$15.62 at 4% 1 mo. 20 da.
12. \$700 at 7½% 2 yr. 3 mo. 12 da.
13. \$30.45 at 8% 15 da.
14. \$163 at 9% 3 mo. 9 da.
15. \$12.60 at 8% 10 da.
16. \$2465.20 at 4% 30 da.

17. $5400 at 8% 30 da.

18. $3870 at 9% 90 da.

19. $4065 at 3% 125 da.

20. $1777.40 at 4% 6 mo. 10 da.

21. Find the bank discount on $425 at 5% for 4 mo. 20 da.

22. Find the true discount on $4343 at 6% for two months.

23. Find the true discount on $591.23 at 8% for 90 da.

24. A note for $67 for 3 months at 8% was paid at maturity. How much was paid?

25. A note given Mar. 17, 1903, was paid Jan. 15, 1904. How much was paid if the rate was 9%?

26. A note for $635 was due July 2, 1904. It was discounted at the bank June 12th at 5%. How much was received?

27. Note for $420 at 8% dated April 20, 1904, is due 90 da. after date but is not paid until ten days after due. Find amount paid.

28. Note for $76.40 at 4% dated June 3 is paid July 6. Find amount.

29. Note for $55.50 at 6% dated Aug. 26 to run 210 da. is paid 10 da. before due. Find amount paid and date when note was due.

30. Note for $135 for 3 mo. was discounted at the bank 20 da. before due. How much did the owner receive?

31. Note for $60 at 7% dated Oct. 12, due Dec. 27, was discounted at the bank Nov. 14 at 6%. How much did the owner receive?

32. Note for $1250 at 5% dated Dec. 4, 1903, for 90 da. was discounted Feb. 21, 1904, at 6%. Find amount paid.

33. A man owes me $125, due in 6 mo. How much will settle the bill now at true discount, if money is worth 8%?

FACTORS.

106. Most numbers below 250000 can be factored by the Manu-Mental process, by dividing by any divisor and recording on the fingers.

A divisor or factor which is more than ten and less than twenty-one can be recorded on one finger by placing the pointer against the right side of the record finger, instead of directly on it.

A divisor or factor which is more than twenty and less than thirty-one may be recorded on one finger by placing the pointer against the left side of the record finger instead of directly on it. (Fig. 21.)

NOTE 26.—Have the student learn all the prime factors below 30. He would find it convenient to know all the prime factors below 100.

107. Illustration 37.

Factor 990.

Record on fingers.

Divide by 2 (recording on thumb) = 495.

Divide 495 by 3 (recording on first finger) = 165.

Divide 165 by 3 (recording on 2d finger) = 55.

Divide 55 by 5 (recording on 3d finger) = 11 (recording on 4th finger).

Then the factors are 2, 3, 3, 5, 11.

108. Illustration 38.

Factor 60697.

Record on fingers.

Divide by 7 (record on thumb) = 8671.

Divide by 13 (record on 1st finger) = 667.

Divide by 23 (record on 2d finger) = 29 (record on the 3d finger).

Then factors are 7, 13, 23, 29.

FIG. 21.
FACTORS.

109. Problems in Factoring:

Find the factor of		Find the prime factor of	
1.	75	1.	98
2.	46	2.	45
3.	64	3.	64
4.	175	4.	81
5.	238	5.	125
6.	346	6.	420
7.	1260	7.	1155
8.	2796	8.	844
9.	146146	9.	21504
10.	278278	10.	124416

110. A factor is a divisor. A factor of two or more numbers is called a common factor or common divisor. The largest common factor of two or more numbers is called the greatest common divisor or highest common factor.

111. To find the G. C. D. of two numbers, divide the smaller into the greater. If there is no remainder the smaller is the G. C. D. If there is a remainder, divide this remainder into the previous divisor. Continue dividing the last divisor by the remainder until there is no remainder. The last divisor is the G. C. D.

To find the G. C. D. of more than two numbers, find the G. C. D. of two; find the G. C. D. of this G. C. D. and the next number; continue this until the last number is used. The result will be the G. C. D. of all. The G. C. D. may be found by factoring the first number and discarding all the factors not found in the others. The product of these factors is the G. C. D.

112. Find the Greatest Common Divisor of

1. 52, 91.
2. 65, 143.
3. 66, 165.
4. 192, 460.
5. 36, 63, 162, 288.
6. 423, 2313.
7. 18584, 24610.
8. 1365, 2093, 2205, 707, 13013.
9. 707, 4949, 16463.
10. 86, 344, 47343, 51686.

MULTIPLES.

113. A multiple of any number may be found by multiplying it by any whole number.

A multiple of any two numbers (called common multiple) may be found, 1st, by multiplying them together; 2d, by dividing both by any common factor and multiplying these quotients and this common factor together; 3d, by factoring the numbers to the prime factors, selecting each prime factor as many times as it is found in any one of the numbers, and multiplying these prime factors together (this is the least common multiple); 4th, by multiplying the L. C. M. by any whole number.

To find the L. C. M. of three or more numbers, find the L. C. M. of two, then find the L. C. M. of this multiple and the next number. Continue this process until all the numbers are used. The final L. C. M. is the L. C. M. of all the numbers.

114. Find the Least Common Multiple of

1. 6, 9, 12.
2. 4, 7, 12.
3. 3, 15, 27.
4. 8, 12, 40, 60.
5. 17, 85, 153, 1836.
6. 69, 161, 153.
7. 15, 30, 75, 105.
8. 45, 48, 80, 135.
9. 2020, 1515.
10. 5226, 7839.

11. What is the shortest distance that can be measured exactly by a 2, 5, 6, or 8 foot rod?

12. I must divide the money I have in my pocket among 5, 6, or 7 boys and give each the same number of dollars. What is the smallest sum I can have in my pocket?

13. A, B and C can walk around the race course in 9, 12, and 15 minutes, respectively. If they start together and each does his best, how long will it be before they are together again at the starting point?

ALIQUOT PARTS.

115. Aliquot parts are simply problems for multiplication and division, and are easily performed by the Manu-Mental process by applying the instructions given in any good arithmetic.

116. Problems in Aliquot Parts:

Find the cost of

1. 160 yd. cloth at 75c. per yd.
2. 75 yd. cloth at 33⅓c. per yd.
3. 1250 lb. prunes at 6¼c. per lb.
4. 2400 bu. corn at 37½c. per bu.
5. 750 bu. oats at 33⅓ c. per bu.
6. 718 lb. wheat at $1.25 per bu.
7. 14250 lb. coal at $6.66⅔ per ton.
8. 22550 lb. hay at 12½c. per cwt.
9. 63 doz. cans corn at 62½c. per doz.
10. Sold 22 hogs at 9.09\frac{1}{9}$ each and bought corn at 20c. per bu. How much corn did I get?
11. Worked 16 days at $2.25 and 24 days at $2.33⅓ per day. Spent $12 and invested the remainder in ducks at $8 per dozen. How many ducks did I get?
12. Sold 40 head of cattle averaging 1200 lb. at 6¼c. per lb. Invested the poceeds in wheat at 75c. per bu. How many bu. did I get?
13. Bought a farm of 320 acres at 14.28\frac{4}{7}$ per acre. Sold one-fourth of it at $15 per acre and the remainder at $16.66⅔ per acre. How much did I gain?
14. A wagon that weighs 1250 pounds weighs 5090 pounds when loaded with coal. What is the load worth if coal is 16⅔c. per bu.?
15. Bought 1½ yd. of platinum wire at 2½c. per in., used 3 ft. 2 in. of it and sold the remainder at 3⅓c. per in. How much did the part I used cost me?

METRIC LENGTH MEASURE.

117. In measuring long distances the meter is the smallest measure generally used: in measuring short distances the meter is the largest measure generally used. As most practical problems deal with the larger or the smaller only, they can be worked on the hand by using the little finger for mm. or M. (Fig. 22.)

If not more than five of the orders are used they may be shifted on the hand, placing meters or any other denomination on any convenient finger; if the problem requires KM. to dm., M. may be placed on the third finger, etc.

118. The meter, which is the standard of length, is 39.3685 inches. For approximate measures consider it 3.3 feet, or 1.1 yards.

119. Problems in addition, subtraction, multiplication, division, reduction ascending, reduction descending or reduction to or from long measure are easily performed by applying the instruction previously given in this book.

METRIC SQUARE MEASURE AND METRIC CUBIC MEASURE.

120. While 100 or 1000 cannot be recorded on one finger, the student will find, if he has been thoroughly drilled on all preceding work, that he can remember the numbers of each denomination with sufficient accuracy to enable him to solve most practical problems in surface and volume measure.

121. The standard for surface measure is the square dekameter, which is called Are and equals 3.954 sq. rd. The square meter is called a Centare and equals 1.196 sq. yd. The ratio of surface measure is 100.

122. The standard for solid measure is the cubic meter, called Stere, and equals 1.3078 cu. yd. The ratio of solid measure is 1,000.

123. The Liter is the unit of capacity. It equals 1 cu. dm. 1.0567 liquid qt. or .908 dry quarts.

124. The standard for weight measure is the Gram, which equals 15.432 grains troy. (Av. lb. =7000 gr. Troy and Apoth. lb. =5760 gr.)

125. Problems in the Metric Systems:

1. Reduce 27 m. to cm.
2. " 4 Hg. to dg.
3. " 6 Dl. to dl.
4. " 4 Km. 5 Hm. 7 m. to dm.
5. " 9 dg. 5 cg. 2 mg. to g.
6. " 2 l. 6 cl. 4 ml. to Kl.
7. " 12 sq. Hm. 65 sq. Dm. 10 sq. m. 86 sq. dm. to sq. m.
8. Reduce 4 Dl. to bu.
9. " 9 l. to gal.
10. " 5 Ares to sq. rd.
11. " 4 Mg. to lb. Troy Wt.
12. " 7 Q. to lb. Avoirdupois Wt.
13. " 12 bu. to liters.
14. " 5 gal. 1 qt. (liquid) to liters.
15. " 25 sq. yd. to sq. m.
16. " 28 sq. m. to sq. ft.

17. Bought 200 bu. oats at 22c. and sold them at $1.50 per Hl. after paying $16 shipping charges. How much did I gain or lose?

18. Bought 20 Steres of wood at $1.50 per Stere and sold it at $6.50 per cord. Find gain or loss.

19. Bought 25 Steres of wood at 8 fr. per Stere and sold it at $7 per cord. Find gain or loss.

20. Bought 15 cords of wood at $8 per cord and sold it at 7 fr. per Stere. Find gain or loss.

FIG. 22.
METRIC LENGTH MEASURE.

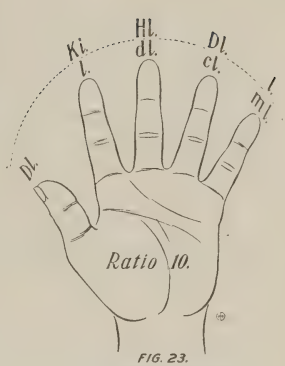

FIG. 23.
METRIC CAPACITY MEASURE.

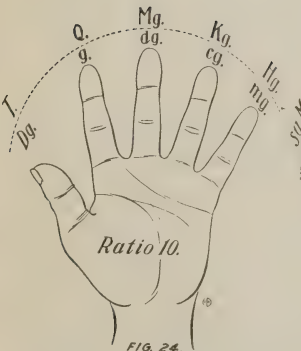

FIG. 24.
METRIC WEIGHT MEASURE.

FIG. 25.
METRIC SQUARE MEASURE.

FRACTIONS.

126. Fractions whose numerators and denominators are less than one hundred may be recorded on the fingers by using the first and second fingers for the numerator and the third and fourth fingers for the denominator. When this is done it is well to spread the third and fourth fingers as in figure 7.

127. Reduction of fractions is performed by recording the numerator and denominator as above and multiplying or dividing both.

128. To add fractions, find the common denominator (L. C. M., page 75,) remember it, but do not record it on the fingers. Reduce each fraction separately to a fraction having that denominator and add the numerators, recording the operation and result on the fingers.

129. Subtraction of fractions may be performed by reducing to a common denominator, recording the numerators and subtracting as if they were whole numbers. The result is the numerator only.

130. In multiplication of fractions the memory must retain the denominators while the numerators are multiplied, and *vice versa*.

131. Fractions are divided by inverting the divisor and multiplying the fractions. (Not theoretically correct.)

NOTE 27.—The work in fractions must be largely mental, as the memory must retain all that cannot be recorded on the hand. In computing with whole numbers and fractions it will often be necessary to separate them and perform the operations separately, then combine the results.

132. Problems in Fractions:

1. Reduce: $\frac{2}{3}$ to 12ths.
2. " $\frac{4}{5}$ to 60ths.
3. " $\frac{16}{17}$ to 68ths.
4. " $\frac{26}{39}$ to 3rds.
5. " $\frac{16}{40}$ to 20ths.
6. " $\frac{25}{60}$ to lowest terms.
7. " $\frac{7}{28}$ to lowest terms.
8. " $\frac{31}{31}$ to lowest terms.
9. " $\frac{6}{90}$ to lowest terms.
10. " $\frac{64}{96}$ to lowest terms.
11. Add: $\frac{2}{3}+\frac{4}{5}+\frac{5}{6}+\frac{3}{4}$.
12. " $\frac{16}{21}+\frac{2}{7}+1\frac{3}{42}$.
13. " $\frac{3}{17}+\frac{2}{5}+\frac{19}{153}$.
14. Subtract: $\frac{57}{93}-\frac{1}{3}$.
15. " $\frac{21}{22}-\frac{6}{7}$.
16. " $\frac{13}{31}-\frac{1}{16}$.
17. Multiply: $\frac{2}{3}\times\frac{6}{7}\times\frac{14}{15}$.
18. " $\frac{7}{8}\times 2\times\frac{13}{23}$.
19. " $\frac{2}{5}\times\frac{7}{8}\times\frac{10}{13}$.
20. Divide: $6\div\frac{2}{3}$.
21. " $\frac{2}{5}\div 7$.
22. " $\frac{3}{8}\div\frac{7}{9}$.
23. " $\frac{1}{6}\div\frac{3}{4}\div\frac{5}{7}$.
24. " $\frac{3}{10}\div\frac{7}{16}\div\frac{3}{14}$.

25. If $\frac{2}{3}$ of a suit of clothes is worth $\$7\frac{1}{2}$, how many days work at $\$1\frac{1}{4}$ will pay for the suit?

26. Corn is worth $\$\frac{5}{8}$ per bu. I sell a load of 25 bu. and buy oats at $\$\frac{1}{3}$ per bu. How many bu. of oats do I get?

27. I bought $\frac{3}{4}$ of a farm and sell $\frac{2}{5}$ of my share for $\frac{1}{2}$ of the cost of the whole farm. What % will I gain if I sell the remainder of my purchase at the same rate?

28. B owns $\frac{1}{3}$ of a tract of land. C owns $\frac{2}{3}$ as much as B. D owns $\frac{3}{4}$ as much as both B and C. E owns the remainder. What part of the whole does he own?

29. Spent $\frac{3}{8}$ of my money for board, $\frac{1}{5}$ of the remainder for clothes, and $\frac{1}{2}$ of the remainder, which is \$10, for car-fare. How much had I at first?

30. I increased my money by $\frac{1}{4}$ of itself at one time and $\frac{2}{3}$ of itself at another. After spending $\frac{2}{5}$ of what I then had, I increased the sum I then had by $\frac{2}{7}$ of itself and found I had \$164. How much had I at first?

BUSINESS COMPUTATIONS.

133. The solution of problems in Percentage, Profit and Loss, Trade Discount, Commission, Equation of Accounts, Custom House Duties, Taxes, Insurance, Stocks and Bonds, Exchange, Partnership, etc., consitsts of two parts; viz., analysis and computation. The analysis must be mental primarily. This book gives sufficient instruction to cover most, if not all, computation needed in practical problems; so that the pencil or chalk need not be used to any great extent.

NOTE 28. The following problems should be worked without using pencil or chalk. After the student has been thoroughly drilled on the preceding principles and problems he can work most of these mentally. The remainder of the problems should be worked manu-mentally. There are but very few problems in school or business arithmetics that cannot be solved by the manu-mental method.

MISCELLANEOUS PROBLEMS.

1. Paid A \$2,467, B \$5,478, C \$986, D \$1,545, and E \$2239. How much did I pay all?

2. Bought beef \$134.20, lard \$35.65, sugar \$86.32, syrup \$68.95, rice \$26.10, pork \$247.80, flour \$306 and apples \$82.05. Find amount of bill.

3. Add 2468, 3507, 9640, 428, 1007 and subtract 862, 587, 5786, 2050 from the sum.

4. Bought for my country store as follows: groceries $2,647, boots and shoes $345, hats and caps $146, clothing $1,431. At the end of the year I find I have sold as follows: groceries $2,132, boots and shoes $357, hats and caps $105, clothing $1,500 and have an inventory of $1638. How much did I gain or lose?

5. A book contains 345 pages. How many pages in 8 volumes?

6. A has $2346 and B has 23 times as much. How much has B?

7. C has 514 cattle which he values at $78 a head. D offered him $1235 less than he asks. What did D offer for the herd? How much per head?

8. A pipe flows 41 gallons per hour. How long will it take to fill a tank that holds 14432 gallons?

9. The school tax was $76229. $965 were spent for repairs and the remainder was divided among 94 teachers. How much did each teacher get?

10. I spent $235 in one month. At that rate how much would I spend in $7\frac{1}{2}$ months? In $12\frac{1}{2}$ months?

11. A company of 24 men have provisions enough for 38 days, and another company of 52 men have provisions enough for 247 days. If the companies are united and the provisions combined, how long will the provisions last?

12. A drover has twice as many hogs as sheep and three times as many sheep as cattle. If the hogs cost $7, the sheep $5, and the cattle $24 each, how many of each did he buy for $5913?

13. If 28 men can do a peice of work in 46 days, how many men must be employed to complete the work in 8 days?

14. If 15 men complete a piece of work in 16 days, how many men must be added to complete it in 12 days?

15. I walk 324 miles in 72 hours. How far can I walk during the month of February, 1904, if I walked 8 hours each day?

16. An ocean steamer travels 21 miles an hour when there is no wind. In crossing to Europe she faces a wind which retards her 4 miles per hour and makes the trip in 214 hours. On the return trip the wind increases her speed 3 miles per hour. How long does it take her to make the return trip?

17. 20 men working 123 days of 8 hours each do a piece of work. How many men will it require to complete the work in 205 days working 6 hours per day?

18. A country store keeper exchanged 4 loads, of 42 bushels each, of wheat worth 55 cents per bushel for 5 bolts of cloth, of 104 yards each. Find the cost per yard.

19. I rode a motor bicycle 23 days of 15 hours each at the rate of 14 miles per hour. I had the following expenses for wheel: gasoline $8, chain $4.60, 4 spokes $1, saddle spring $1.50, oil 75 cents, tire tape 25 cents. How much per mile did my ride cost?

20. If the wheat in a bin 8 ft. high, 12 ft. wide and 24 ft. long is worth $1152, what is the wheat in a bin 15 ft. high, 20 ft. wide and 30 ft. long worth?

21. A, B and C rent a house for $600 per year. A occupies 8 rooms, B 6 rooms and C 11 rooms. How much per month should each pay?

2. E and F own 1948 sheep. Two times the number E has plus 73 equals the number F has. How many have each?

23. Built a stone wall 120 ft. long, 8 ft. high and $1\frac{1}{2}$ ft. thick at $3 per perch. Find cost.

24. How many bricks in a wall around a lot 30 ft. by 50 ft. (on the inside) if the wall is 4 ft. high and 1 ft. thick and contains 26 bricks per cu. ft.?

25. A house 60 ft. long, 35 ft. wide and 20 ft. high (outside measurement) has walls 18 in. thick. If deductions for doors and windows will build the gables, what will the brick cost at $8 per thousand?

26. I have an income of $2000 per year. I spend 25 % for board and room, 10 % for clothing, $12\frac{1}{2}$ % for books, 20 % for traveling, etc. How much do I spend for each and how much do I save?

27. I own 60 % of a farm and sell 35 % of my share for $3405. What is the farm worth?

28. I gave John 30 % of my bank account, paid 20 % of the remainder for insurance, spent $\frac{1}{4}$ of the remainder for clothes and had $1200 left. Find how much I had at first and how much I spent for each item.

29. Give $\frac{1}{3}$ of my property to charity, 5% of the remainder to my wife, 75 % of the remainder to my son, 50 % of the remainder to my daughter and the remainder, $1000, to my brother. Find value of property and how much each got.

30. 20 half chests of Oolong tea containing 75 pounds each at 35 cents per pound were exchanged for coffee at 22 cents per pound. How many sacks of coffee were given if a sack weighs 125 pounds?

31. A wheel, which has 26 cogs, turns a wheel, of ten cogs, that is on the same rod with a wheel of 32 cogs which turns a wheel of 6 cogs. If the 26-cog wheel makes 15 revolutions, how many revolutions will the 6-cog wheel make?

32. Bought a farm of 230 acres at $22.50 per acre. Sold it at a gain of 50 %. After taking out $262.50 for expenses, I invested the remainder in land at $15 per acre and sold it at a gain of $2 per acre. How much did I gain by the total transaction?

33. Bought 28 tons of R.R. rails in Pittsburg, Pa., and sold them at $32 per ton in Sioux City, Ia., after paying $135 for freight. How much did I gain or lose?

34. A produce dealer paid $360 for pears, $150 for peaches, and $130 for apples. He sold the pears at 25 % profit, the peaches at $33\frac{1}{3}$ % loss, and the apples for 90 % of the cost. What did he lose or gain?

35. A dealer bought goods and paid $16\frac{2}{3}$ % of the cost for freight. He sold one-half of the goods at $28\frac{4}{7}$ % gain and the other half at $57\frac{1}{7}$ % gain and gained $600 by the transaction. Find cost of goods, and amount received for each sale.

36. I bought four horses for $150, $225, $400 and $650 respectively. Sold the first at a gain of 50 %, the second at a loss of $11\frac{1}{9}$ %, the third at a gain of $6\frac{1}{4}$ %, and the fourth at a gain of $7\frac{2}{13}$ %. Find total loss or gain.

37. I paid $540 for hardware. Sold $150 worth to one man, and $210 worth to another and find I have $240 worth remaining. What per cent, and how much profit did I make?

38. I bought two horses at $125 each; sold one at a gain of 20 %, and another at a loss of 20 %. How much did I gain or lose on both?

39. I sold two horses at $125 each; on one I gained 25 %, on the other I lost 25 %. How much did I gain or lose on both?

40. I sold a house at 10 % gain; with this money I bought another and sold it at 20 % gain. My total gain was $550. What did each house cost?

41. Bought a farm of 960 acres in Missouri at $12.50 per acre; built a house which cost $2420; a barn which cost $3600 and paid $1375 for fencing. I sold 120 acres at $15 per acre, 240 acres at $25 per acre and the remainder (including barn and house) at $110 per acre. Find the net gain or loss.

42. Bought a note for 12½ % less than its face and discounted it at a bank at 6 % for 60 days. Find my gain or loss.

43. Sold $450 worth of merchandise at 33⅓ % and 20 % off. Find net bill to render.

44. Sold $3500 worth of merchandise at a discount of 50 %, 20 % and 10 %. Find net per cent discount and net amount of bill.

45. A merchant buys clothing at 30 % and 20 % discount from marked value and sell it at 20 % above marked price. How much does he gain?

46. A merchant buys goods at 30 % and 20 % off the marked price and sells it at a discount of 10% and 20% off the marked price. Find his net loss or gain.

47. A discount of 50 %, 30 %, 20 %, 10 % and 5 % is equal to what single discount?

48. Bought $3400 worth of merchandise at 2½ % commission. Find my commission.

49. Sold 500 bu. of wheat at 80 cents a bu. Paid commission 3 %, insurance $25, freight $130. How much did I receive?

50. Sent my agent $1200 to invest after taking out his commission of 3 %. How much did he invest for me?

51. Shipped a carload of 30 cattle to Chicago; they sold for $32.50 each. The commission merchant took out 4% commission and invested the remainder in wheat after deducting his commission of 2% for buying. What was his total commission and how much wheat did he buy at 75 cents a bushel?

52. An agent sold oats on 5 % commission and invested the proceeds in wheat at 75 cents per bushel on a commission of 5$\frac{1}{2}$ %. For how much did he sell the oats if his total commission was $300?

53. Find the interest on $420 at 6 % for 25 days.

54. Find the interest on $950 for 5 months at 9 %.

55. Find the interest on $2560 for 70 days at 8 %.

56. A note for $420 dated June 3, 1903, was paid Oct. 5, 1903, with 6 %. Find amount paid.

57. A note for $3240 dated Feb. 3, 1894, for 60 days without interest was paid Apr. 25, with 6 % interest after due. Find amount paid.

58. A note for $785.10 dated Sept. 23 for 45 days without interest was paid Nov. 17 with 8 % interest from due. Find amount paid.

59. A note for $400 dated Mch. 4, 1904, was paid May 1 with 9 % interest from Feb. 20. Find amount of payment.

60. A note for $300 is dated Jan. 1, 1904, at 6 %. The following payments were made: Feb. 10, 1904, $22; Mch. 11, 1904, $1; Apr. 25, 1904, $82.50. What was due June 7, 1904, by the United States rule for partial payments?

61. A note for $465.10 at 8 % interest is dated June 12, 1902. The following payments are endorsed on it: Aug. 20, $51.84; Oct. 12, $5; Nov. 4, $25. What is due Dec. 12, 1902?

62. A note for $1430 at 8 % interest, dated Apr. 23, 1902, has the following endorsements: June 10, 1902, $50; Aug. 28, 1902, $10.50; Nov. 4, 1902, $100; Dec. 20, 1902, $10; Mch. 1, 1903, $15.10; May 25, 1903; $50; June 10, 1903, $35.45; Sept. 30, 1903, $325.30. What was due Dec. 3, 1903?

63. A man invested $12500 in business. At the end of 2½ years he drew out $17000, which represent the investment and gain. If his services were worth $1200 per year, what per cent did he receive on his investment?

64. A building costs $125000; receipts from rents, etc., produce $34500, lighting and heating costs $8400, taxes $5000, insurance $2400, repairs $3500, janitor service, etc., $2000. If the agent charges 3 % for collecting, what per cent does the investment net me?

65. I loaned $3500 at 8 % compound interest for 3 years 4 months. How much should I receive?

66. I paid $800 freight on a carload of goods received from New Orleans. The insurance and drayage cost me $130. I sold the goods for $3600.85 and thereby gained 16½ % on the total cost. Find what the goods cost in New Orleans.

67. I invested $52000 in business. The first year I gained 6 %, the second year 15 %, the third year 45 %, the fourth year I lost 10 %. If the gain was added to the capital each time and the per cent of gain or loss taken on the new capital, what was the business worth at the end of the fourth year and what was my net per cent gain on the original capital?

68. A man loaned me $500 for four months at one time and $800 for nine months at another time without interest. For how long should I lend him $1000 to balance the accommodation.?

69. I owe a man $400, payable today, and $800, payable in 24 days. By his consent I decide to pay it all in one payment. When should the settlement be made?

70. March 1, I buy $800 worth of goods on 30 days time, $500 worth of goods on 40 days time and $1000 worth of goods at 60 days. When should I make settlement if I paid the three bills at one time?

71. On April 10, I purchase $450 worth of goods at 90 days, Apr. 15, $800 at 30 days, Apr. 28, $200 at 10 days, May 10, $800 at 60 days, June 4, $850 at 30 days. What should be the date of settlement, if the bills were all paid at once?

72. I owe $500 which should be paid on Apr. 23. I pay $200 Apr. 10. When should the remainder be paid?

73. Find the specific duty on 850 pounds of coffee at 4c., 3500 pounds tea at 10c., 500 pounds rice at ½c.

74. Find the ad valorem duty on 450 yd. of cloth at 8c., 520 yd. of carpet at 65c., 345 bottles perfume at 55c. and five cases of drugs at $22. If the ad valorem duty for the drugs and perfume is 65% and the cloth and carpets 10%.

75. Find the duty on 1550 yd. of silk invoiced at $1.10 per yd. with 15c. a yard specific, and 2 % ad valorem duty.

76. I imported 500 pounds woolen goods invoiced at £620. The duty is 22½ cents per pound and 30 % ad valorem. If I sell the goods at a gain of 20 % on the total cost, how much do I receive?

77. I imported 320 dozen German, brass lined pocket knives, valued at 8 marks per dozen, with a specific duty of 25 cents per dozen and 20 % ad valorem. If I sell them at a gain of 40 %, how much do I receive?

78. Imported 3 doz. (100 lb. each) Swiss cheese invoiced at 2 centimes per milligram (Approx. 2.2 lb., Av.) with 25 % ad valorem and $1.20 per cwt. specific duty. For what must I sell it to gain 20% on the total cost?

79. I owned $4,500 real estate and $2,750 personal property, the rate of taxation 3.5 mills on the dollar. How much do I pay?

80. The property is a village is valued at $240,000. There are 130 polls at $1.25 each. The rate of taxation is 2.6 mills on the dollar; I own $5,000 worth of property and pay one poll tax. How much tax do I pay, and how much does the village raise?

81. The taxable property in a town is valued at $650,000. There are 535 polls at $1.25. The total tax raised is $15,293.75. What is the rate of property taxation?

82. The property in a town is assessed at $12,500,000, the rate of taxation is $2\frac{3}{4}$ cents, there are 450 polls at $1.50. What is the total tax, and what does A pay, if he owns $10,250 worth of property and pays one poll?

83. Insured my property for $12,000 at $\frac{3}{4}$ %. How much premium do I pay?

84. My property is valued at $7,000. I insure one-half of it in one company at $\frac{1}{2}$ % and one-third of it in another at $\frac{3}{4}$ %. If the premium is paid in advance and the property is entirely destroyed, what is my loss?

85. A company insures a block for $250,000 at 75 cents per hundred, but thinking the risk too great, they reinsure one-fourth of the block in another company at 8 mills and two-fifths of the block in a third company at 8½ mills. How much risk does the original company carry and how much does it get for carrying this risk?

86. My factory is insured with one company for $4,000 and with another for $9,000. $15,000 damage is done by fire. How much do I lose and how much does each company lose, if my rate of insurance was 75 cents per $100?

87. The Baltic is valued at $6,500,000 and is insured for $1,500,000 on a pro rata policy at 2½%. A fire does $325,000 damage; what is the premium and how much damage does the insurance company pay?

88. I bought 50 shares of stock at 95, 20 shares at 104 and 75 shares at 106. How much did I pay for all?

89. I bought 265 shares of American Steel stock at 110 and paid ⅛% brokerage. How much did it cost me?

90. I purchased 50 shares C. B. & Q. R.R. stock at 113½ and 50 shares N. Y. Central at 119 through my broker. I sold the C. B. & Q. R.R. stock at 115 and the N. Y. Central stock at 120. If my broker charged ⅛% for buying and ⅜% for selling, how much do I gain on the transaction?

91. Traded 100 shares of D. L. & W. R.R. stock at 265 for 225 shares of L. & N. R.R. stock. What does one share of L. & N. stock cost me?

92. Paid my broker $250 for selling stock; brokerage ⅛%. How much stock did he sell at par?

93. I paid my broker $4,342.50 to cover purchase and brokerage of 45 shares of Atchison, Topeka and Santa Fe R.R. stock. What does stock sell at?

94. The Gardner Governor Works has a capital of $300,000. The gross earnings are $69,520, the gross expenses are $27,260. $15,000 worth of bonds are paid off, what even per cent dividend can be declared and how much would be left for the surplus fund?

95. We paid $8,400 on outstanding bonds, $17,000 expenses, declared a dividend of 6 % and placed $7,600 in the surplus fund. What is the capitalization of the company?

96. A, B, and C formed a partnership. A invested $800, B invested $1,000 ,C invested $1,300. They gained $1,240. How much should each receive?

97. F and G formed a partnership. F invested $5,850 for 10 months, G invested $2,960 for 15 months. They gained $5,145. How much should each have?

98. H and J formed a partnership. H invested, $4,500, J invested $500 and devotes his time to the business. If his work is worth one-third of his investment how much of the $2,600 gain should each receive? If the partnership is dissolved at the end of the year, how much should each receive, including investments and profits?

99. An estate has to be divided among the wife, two sons and three daughters. The wife is to have one-third of the property, each son is to have twice as much as each daughter. If the property is worth $31,500, how much did each receive?

100. X, Y and Z formed a partnership for one year; each to devote his entire time to the business. X invests $2,000 and withdraws $1,000 at the end of nine months; Y invests $3,000 and at the end of six months, $1,000 more; Z invests $4,000 and withdraws $2,000 at the end of eight months. Owing to illness X was unable to attend to business for three months. If the labor of each man is considered as worth $2,000 per year, how should a profit of $5,025 be divided?

THE END.

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